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General Technical Report INT-237

Management of Small-Stem Stands of Lodgepole Pine-Workshop Proceedings

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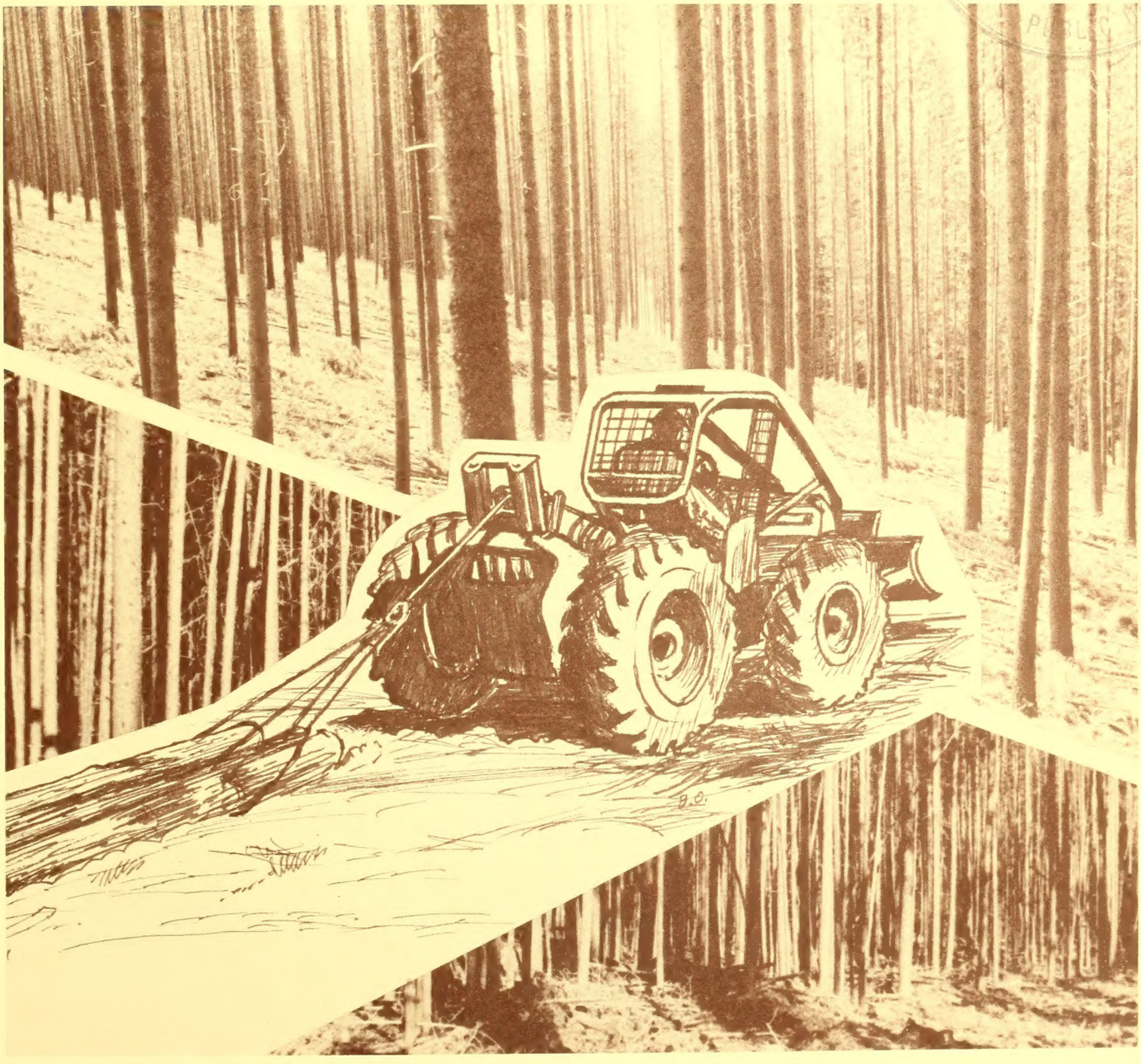

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October 1987

Intermountain Research Station
324 25th Street
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ERROR

In General Technical Report INT-237, "Management of small-stem stands of lodgepole pine--workshop proceedings," figures 5 and 6 on page 56 should be interchanged.

Management of Small-Stem Stands of Lodgepole Pine—Workshop Proceedings

Fairmont Hot Springs, MT, June 30-July 2, 1986

Compiler:

ROLAND L. BARGER, Program Manager (retired),
Intermountain Research Station,
Forest Service, U.S. Department of Agriculture

Workshop Sponsors:

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CONTENTS

The Management Challenge

Chaired by: Roland L. Barger

Small lodgepole pine—especially subsawtimber pole stands of young or older stagnated trees—presents a significant management challenge across much of the Inland West. Lodgepole pine occurs in quantity in eight western States and is the principal species in more than a dozen National Forests. In addition to representing a wood fiber resource, small lodgepole pine occupies lands important for watershed, wildlife, recreation, and other uses. Effective multiresource management of these lands is essential. Information presented in this section describes the extent and character of the resource, and discusses management issues and options.

EXTENT AND CHARACTER OF SMALL-STEM LODGEPOLE PINE STANDS IN THE MOUNTAIN WEST

Carl E. Fiedler

ABSTRACT: Lodgepole pine (var. latifolia) is one of the most widely distributed pines in western North America, extending from southern Colorado north to the central Yukon, and from 1,500 to 11,500 feet in elevation. This paper focuses on stands below sawtimber size (<9.0 inches diameter at breast height [d.b.h.]). About 4.5 million of the 12.6 million acres of lodgepole pine in the Mountain West are classified in this submerchantable category. Typically, small-stem lodgepole pine stands are of fire origin, over 50 years old, and moderately to heavily overstocked. Maturing stands with >2,000 trees per acre (tpa) are unlikely to yield traditional sawtimber-size trees (>9 inches d.b.h.), and stands with >3,000 tpa will produce few stems >7 inches d.b.h. Overstocked lodgepole pine are tall relative to their diameter, cylindrical, uniform in size, and have short crowns with small branches. These characteristics correspond well with roundwood uses.

INTRODUCTION

Some years ago, Hutchison (1964) reported that "the popular impression of lodgepole pine is of a skinny tree growing out on the edge of nowhere." He noted that this was probably an apt description of lodgepole pine (*Pinus contorta* Dougl. ex Loud.) forests, as well as a primary source of the economic problems limiting large-scale utilization of this species.

Only recently have developments in harvesting technology and widespread availability of specialized equipment for harvesting and processing small trees allowed increased utilization of lodgepole pine. Two factors have been largely responsible for bringing about these changes. First, a dwindling old-growth timber supply in the West has shifted emphasis toward increased utilization of smaller diameter material such as lodgepole pine. Second, and probably more important, what traditionally has been only casual interest in lodgepole pine forests has evolved, due to the recent mountain pine beetle (*Dendroctonus ponderosae* Hopkins) epidemic, into critical concern about the future of this resource. The beetle epidemic has brought about a sharply accelerated harvest program to salvage existing and imminent mortality, and has heightened awareness of the importance of actively managing lodgepole pine to prevent similar large-scale epidemics in the future. Lack of management in the past, for whatever reason, has left today's manager in the unenviable position of having to react to crises, rather than being able to direct stand development by applying appropriate intermediate treatments. Improved utilization opportunities in the future could make the latter scenario a reality.

The purposes of this report are (1) to describe the extent of the lodgepole pine resource in the Mountain West in terms of acreage, location, and availability, and (2) to describe the character of lodgepole pine in terms of the biological and physical attributes that affect stand development and utilization.

EXTENT

The mountain variety of lodgepole pine (var. latifolia) is one of the most widely distributed pines in western North America, extending from southern Colorado north to the central Yukon, and from 1,500 to 11,500 feet in elevation (fig. 1). Lodgepole pine forests occupy about 12.4 million acres within the United States portion of this broad geographical area (Barger and Fiedler 1982). These forests contain about 25 billion cubic feet of growing stock and 65 billion cubic feet of sawtimber, approximately two-thirds of which is in Montana, Idaho, and Oregon (Lotan and Perry 1983). However, this report focuses on only a subset of the lodgepole pine resource--stands below traditional sawtimber size (0.1 to 8.9 inches diameter at breast height [d.b.h.])--hereafter referred to as small-stem stands.

About 5.7 million acres of lodgepole pine in the Mountain West are classified as poletimber (5.0 to 8.9 inches d.b.h.), and more than 1.9 million acres as saplings/seedlings (0.1 to 4.9 inches d.b.h.) (table 1). An unknown additional amount of lodgepole pine poletimber and saplings/seedlings occurs in the Pine Subregion of eastern Oregon and eastern Washington. Assuming that these two size classes comprise the same proportion of the lodgepole pine resource there as in the Northern Rocky Mountains, then the total area occupied by small-stem stands in the Mountain West exceeds 7.6 million acres.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Carl E. Fiedler is a research specialist at the University of Montana, Montana Conservation and Experiment Station, Missoula, MT.

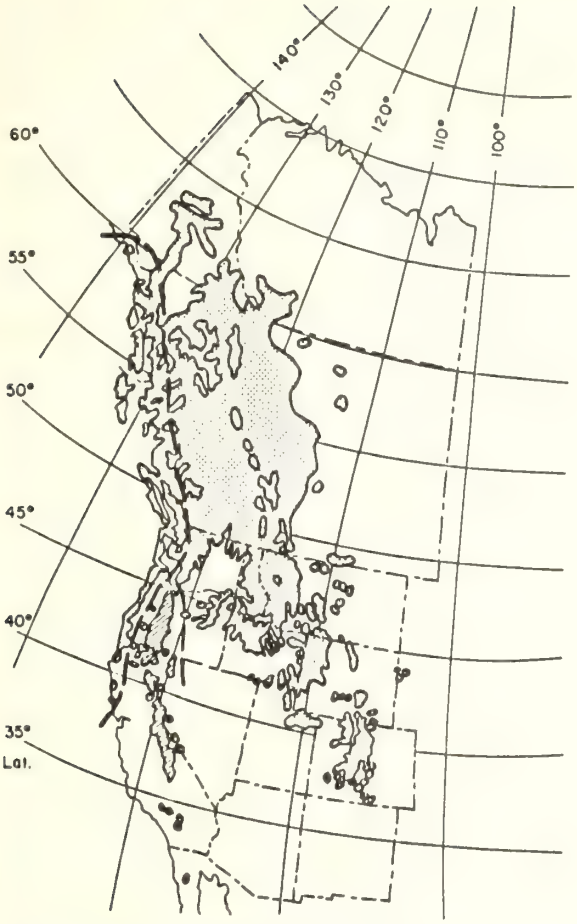

Figure 1--The range of lodgepole pine extends from southern Colorado to the central Yukon. The mountain variety (var. latifolia) is shown to the right of the dashed lines.

The problem with these estimates from the standpoint of utilization is that they are developed from Continuous Forest Inventory data, and cannot be disaggregated into acreage estimates for individual small-stem stands and specific locations. Furthermore, stand level information that may be needed to promote utilization is usually not available because stand examination inventories have generally not been done (Fiedler and others [review draft]).

From the standpoint of utilization, the extent of the lodgepole pine resource is the acreage available for harvest, rather than the physical supply, and the two are quite different. The acreage of small-stem stands that is actually available for utilization is not precisely known, but it is significantly less than the estimated physical supply of 7.6 million acres. Availability is affected by three major factors:

1. Administrative classifications and constraints
2. Terrain
3. Distance to roads.

Administrative Classifications and Constraints

Large acreages of commercial forest land in the Mountain West have been placed in productive reserved or deferred land use classes. Productive reserved lands are those included in wilderness areas, administrative sites, natural areas, and other classifications that preclude all harvesting activity. For example, extensive stands of lodgepole pine provide the dominant backdrop in numerous national parks, wilderness areas, and other areas of scenic and recreational importance. Consequently, about 4.3 million acres of

Table 1--Area of lodgepole pine in the Mountain West by region, State, and size class[1]

Location	Sawtimber ≤9.0 inches d.b.h.	Poletimber 5.0 to 8.9 inches d.b.h.	Saplings/seedlings 0.1 to 4.9 inches d.b.h.	Total
	Thousand acres			
Northern Rocky Mountains				
Montana	1,632.8	2,450.5	742.3	4,825.6
Idaho	905.3	772.6	606.9	2,284.8
Wyoming	557.5	521.1	70.7	1,149.3
Total	3,095.6	3,744.2	1,419.9	8,259.7
Southern Rocky Mountains				
Colorado	459.0	584.7	83.0	1,126.7
Utah	272.4	220.8	37.7	530.9
Nevada	5.8	0	0	5.8
Total	737.2	805.5	120.7	1,663.4
Rocky Mountain Total	3,832.8	4,549.7	1,540.6	9,923.1
Pine Subregion				
Eastern Oregon and Eastern Washington	[2]935.1	1,131.0	428.9	2,495.0
Mountain West Total	4,767.9	5,680.7	1,969.5	12,418.1

[1]Summarized from Green and Setzer (1974) and USDA FS (1978).
[2]Only total acreage of lodgepole pine was available for the Pine Subregion. Acreage estimates of sawtimber, poletimber, and saplings/seedlings were developed using proportions by size class for the Northern Rocky Mountains.

the entire 12.4-million-acre lodgepole pine resource has been placed within productive reserved or deferred land use classes, thereby precluding timber harvest (Barger and Fiedler 1982). Assuming that the proportion of the total lodgepole pine acreage that falls under these restrictions applies equally to small-stem stands, about 2.6 million acres are in reserved or deferred status.

Availability is further limited on public lands by policies and regulations that place harvesting constraints on some stands that are otherwise available. Availability in these cases depends less upon characteristics of the individual stand than upon the larger environment within which the stand occurs. Examples include limits on the proportion of a watershed that can be harvested within a given period, constraints on activities within threatened and endangered species habitat, and constraints on road development due to soils problems or water quality concerns. Thus, the proportion of the small-stem lodgepole pine acreage within an administrative unit that is actually available for harvest at a given time may be relatively small, and not sufficient to supply large-scale proposed uses.

Coston (1985) reports that reliable figures will not be known on the supply of lodgepole pine available for timber harvest until decisions are made about which areas will be added to the National Wilderness Preservation System, and what special considerations will limit standard harvests in other critical areas.

Terrain

A survey of national forests in the Mountain West with significant lodgepole pine acreage found that 25 percent of this resource is located on terrain too steep for conventional tractor logging (Benson and others [review draft]), thus requiring high-cost harvesting systems. Gonsior and Johnson (1985) reported that lodgepole pine's relatively small size and low value do not lend it well either to high-cost, ground-based logging equipment or to cable harvest on steep terrain, because piece size is generally inversely related to harvest cost. Conversely, low-cost and reduced-size harvesting systems are not yet efficient enough to offset smaller piece size and keep harvest costs constant per unit of output.

Depending on the situation, these factors may result in a significant reduction of the acreage of small-stem lodgepole pine actually available for harvest. Harvesting lodgepole pine on steep terrain may also require dealing with such factors as difficult and costly access, environmental constraints, and multiple-use considerations.

Distance to Roads

The issue of access and road-building needs in western forests is probably nowhere more acute than in the lodgepole pine type. Lack of adequate transportation systems is a primary obstacle to the solution of utilization problems in this forest type (Hutchison 1964). Benson and others (review draft) reported that an estimated 65 percent of small-stem stands in the Forest Service's Northern Region are accessed, while only 20 percent are accessed in the Intermountain Region. Hutchison (1964) estimated that at the present rate of road building in the lodgepole pine type, only 60 percent of the necessary road system would be in place by the year 2000.

In spite of the significant reductions in, and restrictions on, the physical supply of lodgepole pine, available supply exceeds demand in most areas. The prevailing view is that the principal barrier to utilizing available small-stem stands is financial; that is, the cost of harvesting and processing the material in these stands exceeds the value of products recovered (Barger 1982).

TREE CHARACTERISTICS

Lodgepole pine trees in overstocked stands are tall relative to their diameter, uniform in size, with thin bark, short crowns, and small limbs. The size, bole form, and treating and machining characteristics of small-stem lodgepole pine correspond well with roundwood uses (for example, posts, poles, tree props, and grape stakes) (Coston 1985). Ironically, better management and earlier density control would compromise some of the desirable utilization attributes unique to small-stem lodgepole pine. The fact that lodgepole pine dries well, is light in weight, and contains small tight knots also makes it competitive with other species for manufacture into sawn products (Van Hooser and Keegan 1985). For example, in 1981, lodgepole pine comprised 31 percent of the timber processed into lumber in Montana, more than any other species (Keegan and others 1983).

STAND CHARACTERISTICS

Stands that comprise the small-stem lodgepole pine resource have several distinguishing characteristics: a vast majority originated from wildfire, most are over 50 years old, and most are moderately to heavily overstocked. It is evident from the last two characteristics that trees in these stands are small because of overstocking, not because they are young. Managers are currently faced with a dilemma in deciding what to do with such stands. Despite the fact that most small-stem stands are "below-cost" chances from a harvesting standpoint, there are several compelling reasons for wanting to extend utilization and management into these stands.

First, maturing stands with >2,000 trees per acre (tpa) will yield few trees $\geq$9 inches d.b.h., and stands with >3,000 tpa are unlikely to yield many trees $\geq$7 inches d.b.h.

Second, volume yield of severely overstocked stands may be far below site potential. Smithers (1961) presented an example of the effect of overstocking on volume production for two lodgepole pine stands in Alberta. These stands were located less than 200 feet apart on a flat bench,

and showed no difference in soil profile or texture.

Characteristics	Stand 1	Stand 2
Age (yr)	75	60
Density (tpa)	9,000	860
Diameter (inches)	1.8	6.0
Basal area (ft^2)	161	167
Height (ft)	33	58
Volume (ft^3)	1,757	4,440

Conclusions that can be drawn from these data are that very high density has little effect on either basal area carrying capacity or gross increment in basal area. However, cubic volume, because of its dependence on average height, is greatly reduced by stagnation.

Finally, because most maturing small-stem stands have only moderate to low biological potential to respond to silvicultural treatments, thinning solely from the standpoint of increasing merchantable yield is generally not justified. However, Hutchison (1964) notes that it is impossible to separate the timber-growing and multiple-use considerations in lodgepole pine management. He contends that the explosive buildup in insect and fire potential in many unmanaged stands may result in higher economic costs in the long run for no management than for management. Furthermore, increased nontimber benefits resulting from silvicultural treatment of small-stem stands may well outweigh any increase in merchantable volume increment. In fact, timber harvest may be the most useful tool available to managers for achieving nontimber objectives related to wildlife habitat; recreational opportunities; watershed management; and insect, disease, and fire control (Barger and Fiedler 1982).

Two factors, wildfire and cone serotiny, are primarily responsible for the overstocked conditions in small-stem stands. Because cone serotiny is an adaptation to fire (Perry and Lotan 1979), these factors usually work in combination. Development and recycling of a vast majority of small-stem stands fit the following general pattern: Dense lodgepole pine stands develop and mature. As these stands start to break up, fuels accumulate and fire hazard builds to an explosive potential. Wildfire inevitably follows, and tremendous numbers of seeds--equivalent to several or many years' seed production--are subsequently released from serotinous cones. Dispersed seeds fall on highly receptive seedbeds and encounter little or no vegetative competition. Dense young stands regenerate, and the cycle repeats.

Regenerated stands vary widely in density due to differences in fire intensity, seedbed condition, age and density of the previous stand, and available seed supply. However, Smithers (1961) found that dense stands remain dense, regardless of site quality. He also reported that overstocked lodgepole pine do not express dominance well. Thus, overstocked stands mature with little crown differentiation and only minor suppression mortality until late in the life of the stand.

Successionally, most small-stem stands can best be described as playing a "persistent" role. Pfister and Daubenmire (1975) assign this successional role in situations where lodgepole pine is the dominant cover type in even-aged stands, with little evidence of replacement by shade-tolerant species. The success of this highly intolerant, pioneer species in capturing and maintaining site occupancy can be attributed to three factors:

1. Repeated fires may have eliminated seed sources of other species.

2. Lodgepole pine stands may be too dense to allow other species to regenerate.

3. Light surface fires may selectively remove seedlings of less fire-resistant species such as Engelmann spruce (*Picea engelmannii* Parry ex Engelm.) and subalpine fir (*Abies lasiocarpa* [Hook.] Nutt.).

However, Pfister and Daubenmire (1975) report that current knowledge does not allow confident projection of "persistent" lodgepole pine stands to eventual climax status.

The rotation age of lodgepole pine stands varies greatly over the species' range. Stands in northeastern Washington and northern Idaho start breaking up at ages of 80 to 100 years (Lotan and Perry 1983). Stands in northwestern Montana are similarly short lived. Nevertheless, stands at higher elevations in Montana may last several hundred years (Tackle 1961), and stands over 300 years old are common in southwestern Montana and northwestern Wyoming (Lotan and Perry 1983).

The lengthy biological rotation of lodgepole pine stands over most of the species' range is fortunate from the standpoint of utilization. This attribute of "storing well on the stump" provides additional time to develop financially feasible systems of recovery and utilization.

More than 20 years ago, Hutchison (1964) outlined two possible scenarios for utilization of the lodgepole pine resource. The first scenario proposed that the lodgepole pine type was in fact excess timberland, unlikely to be needed to meet timber requirements in the foreseeable future. The second suggested that this species had not yet come into its own, and that time and national need would remove the marketing handicaps that had long plagued development and utilization of this resource. The current situation is probably best described as an extended transition period between the two scenarios, but it more closely fits the second.

Significant gains made over the last two decades suggest that the problem of utilization and management of lodgepole pine can gradually be overcome through continued improvements in inventory, access, harvesting, processing, product development, and marketing. Increased utilization of this species resulting from progress on any or all of these fronts would not only contribute to the nation's long-term timber supply, but would also increase the nontimber benefits from this

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extensive, valuable, and distinctive Rocky Mountain forest resource.

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RESOURCE MANAGEMENT ISSUES AND DIRECTION FOR LODGEPOLE PINE FOREST LANDS--NORTHERN ROCKY MOUNTAINS

Alfred S. Gilbert

ABSTRACT: Lodgepole pine occurs on a wide variety of sites and has a number of advantages including prolific and consistent seed production, rapid juvenile growth, and wood with characteristics that are desirable for human uses. On the negative side, it frequently occurs in dense stands, is short lived and subject to catastrophic losses, and has a low stumpage value. Lodgepole pine has long been recognized for its usefulness in producing various timber products. At the same time lodgepole pine sites provide cover and forage for wildlife, feed for livestock, cover for watersheds, pattern and color to scenic vistas, shade for campgrounds, and frequently pay for the roads that help us see these things. Lodgepole pine has different values to different people. In many cases these values can be conflicting. Our challenge is to manage these lands so that they best produce what people want from them.

LODGEPOLE PINE--THE SPECIES

Lodgepole pine has a number of advantages in comparison to other trees in the Western United States. It has very wide distribution and is able to exist on a wide variety of sites. Second, it produces seed at a very early age and on a relatively continuous basis. It also has the ability, through serotinous cones in many of the stands, to store tremendous quantities of viable seed on the site. A third advantage is that it appears to express dominance at a relatively early age, thus providing opportunities to thin young stands and possibly achieve genetic gains. Fourth, the wood has characteristics that many people like. You know what I mean if you have ever had the pleasure of quickly driving a nail into a lodgepole pine stud versus bending the nail or splitting a corner off one of our more valuable larch or Douglas-fir studs. From the standpoint of this workshop, perhaps one of the chief advantages is that this is one of the few western softwoods that people are willing to buy in significant amounts when it comes in small sizes.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Alfred S. Gilbert is staff officer for Timber Management, Fire and Soil/Air/Water, Gallatin National Forest, Forest Service, U.S. Department of Agriculture, Bozeman, MT.

As with any good thing, there are disadvantages too. The advantage of prolific seed production can result in the disadvantage of overstocked stands. This results in a decrease in the various benefits that might come from the stand or an increase in the cost to get it to the condition we would like it to be in. A major disadvantage is that the species is relatively short lived and is subject to catastrophic damage by fire, mountain pine beetles, and wind. Another disadvantage is that the species just does not grow as big as some of its neighbors or produce as much volume per acre. Therefore, it tends to have low stumpage values.

RELATIONSHIP TO VARIOUS RESOURCES

Lodgepole pine forests afford a full spectrum of potential resources and uses, including wood products, recreation opportunities, wildlife habitat, water, and forage. Management is rarely directed toward a single resource or use, but rather toward an integrated mix of resources. Characteristics of lodgepole pine as related to various resources are consequently of major importance in defining management issues and direction.

Timber

Lodgepole pine historically has been used for firewood, houselogs, and posts and poles. In southwestern Montana, significant acreages of lodgepole pine were harvested to produce mine timbers and fuel for the smelters. Throughout Montana, many lodgepole pines were converted to railroad ties. In the mid-1950's, large quantities of lodgepole were cut into pulpwood bolts and shipped back to Minnesota for processing. However, technology to efficiently handle small-diameter stems did not come about until the early 1960's so that significant quantities could be milled into studs and lumber.

Today's uses of lodgepole pine are lumber, houselogs, posts and poles, firewood, and until recently, railroad ties. Mining activities have not maintained their share of the market, but some other uses such as power poles and core stock for plywood have developed. The share of the market that lodgepole is supplying is increasing (12 percent in 1969 to 25 percent in 1981), and the amount of lodgepole available is being better utilized (about 20 percent of annual growth in the 1950's compared to about 65 percent in 1984). Lodgepole certainly is not the weed

species that it was perceived to be just a few decades ago.

Looking into the future and considering lodgepole pine's assets, it appears that the fiber market could be an area of large opportunity.

Wildlife

Just by virtue of the extensive areas of land that lodgepole occupies, it has a significant effect upon wildlife.

Because of the seral role that lodgepole occupies in most cases, it is usually not associated with the old-growth-related wildlife species. However, it does play a role in providing consistent supplies of seed for squirrels (a favored prey of the marten), and the dead and down remains of lodgepole are often important in providing niches for ants, which are important food sources for piliated woodpeckers.

The cover and forage associated with lodgepole pine forests provide homes to large numbers of deer and elk. The elk are more efficient in their use of this environment because of their willingness to eat grasses and shrubs in the meadows; the deer tend to prefer forbs in either the forested or meadow environment. Because of this, there may be more potential to improve conditions for deer through the increased number of forbs produced when the forested community is disturbed. The benefits are often considered to be short lived (about 20 years), but can be extended through thinning.

Livestock

Lodgepole pine is generally considered to have limited value to livestock. This is due both to the quantity and quality of forage produced. Studies indicate that disturbance (clearcutting) does increase forage production for about a 20-year period and that the effect peaks about 11 years after the disturbance. The benefits can be enhanced and extended through seeding of early season grasses and by thinning.

Many concerns have been expressed about the impacts of cattle grazing on tree regeneration. It is generally acknowledged that the effect is due to trampling rather than grazing damage. Damage can be extensive in areas that are overgrazed. It appears that compatibility can be achieved with proper livestock management.

Watershed

The extensive stands of lodgepole pine provide protection to a large number of watersheds. They are important in providing us with cool water of high quality. However, as mentioned earlier, these stands are subject to catastrophic losses. Vegetative manipulation on those scales can be quite damaging to watersheds on at least a short-term basis. Planned manipulation of the vegetation has potential to provide additional amounts of water downstream and to affect the timing of runoff to some extent. It might very well be that in the future increased water is the most valuable of the products that is realized from our manipulation efforts.

Recreation

Stands of lodgepole pine provide patterns and color to many of our scenic vistas. They are also where a number of our developed recreation sites are located. The harvest of timber (including lodgepole) has paid for most of the roads that provide us with motorized recreation and created favorable sites for berry production and winter sports play areas. Our long-range management plans must consider user safety and convenience in being able to use these lands.

MANAGING LODGEPOLE PINE FORESTS TO MEET HUMAN DESIRES

The point I have been trying to make is that the products lodgepole pine forests produce are not limited to boards, or posts, or firewood. They include a wide number of things that various segments of our society desire.

Lodgepole pine has different values to different people. To some, the highest value is the potential for a wood product; to others, it is an opportunity to manipulate to improve conditions for something else; and to still others, it is something that best serves their purpose by remaining totally undisturbed in a "natural" state.

In many cases, these values are desired on the same piece of land. Resolving the conflict is one of our major management issues. It is not a situation of growing a product and then offering it to the highest bidder. Although "market value" might help to resolve some of the conflicts, many are expressed in qualitative terms. These are difficult to compare against the other values. In some cases, the value might even be expressed as a constraint against another use.

Sales Below Cost

An example of the latter case is the issue of timber sales "below cost."

Lodgepole pine is an aggressive species that can grow on harsh sites better than many of its associates. Because of this, many lodgepole stands occupy sites that are relatively difficult to develop access to. Many of the higher elevation areas are in esthetically sensitive areas and require special layout techniques. Especially in the eastern part of our area, many of the stands are interspersed with nonforested areas. These sites have other resource values, but do not contribute toward the cost of developing roads into the area. As in the case of the visually sensitive areas, particular care must be taken in laying out a timber sale.

In some cases, other resource values such as big game, threatened or endangered species, old-growth dependent species, and water temperature might require certain management constraints to optimize the desired conditions.

Finally, lodgepole pine comes to us in small packages and is relatively expensive to harvest and manufacture.

All of these things add up to quite a bit of expense. When other factors are added in, such as low competition in some areas, extended rotations, or infrequent reentry periods, then the initial entry might not cover all of its costs.

In determining whether or not this situation is acceptable, we must consider whether the costs of the timber sale are appropriate over time, what the costs would have been by implementing some alternative treatment method, and what the costs would be of foregoing the treatment. If the sale cannot meet those tests, then it probably deserves the bad name that it has received.

Lodgepole is Short Lived

Many people who favor nonwood uses for our lodgepole stands strongly defend leaving the stand "natural" or "keeping it just like it is." I submit that this approach ignores one of the realities of lodgepole pine, which is that it is a relatively short-lived species that is very prone to catastrophic occurrences.

Extensive areas, primarily in the Kootenai, Flathead, Beaverhead, and Gallatin National Forests and Glacier and Yellowstone National Parks, have recently experienced mountain pine beetle epidemics. At first, many people's reactions were displeasure that we had not done something to keep their forests from becoming red and subjecting them to the risk of extensive wildfire. Now that the forests are a grayish-green color, these people are again asking that the forest be kept the way it is. I suspect that not until extensive quantities of these dead trees start to come down and people have trouble making their way through the woods, will they again question leaving it "natural."

In the past few years, some of our large wildfires have reminded us that even though we have much better access to the areas, and have gained tremendous capability in personnel, equipment, and techniques, we still are not able to keep the vegetative manipulation within the desired scope. We have unrealistically constrained timber harvesting in areas where the end result was loss of timber to insects or fire--not maintenance of a desirable stand.

MANAGING WITH CONFIDENCE

What does all of this discussion lead up to? Should we duck into our holes and wait for the good old days to return? I submit that we cannot and should not do this. As with the case of the big fish and the easy elk, it just is not likely that the good old days will ever return; in fact, they may never have existed. Each era seems to have its set of problems (no markets, no access, and so forth).

First, we have acquired a tremendous amount of knowledge about the characteristics of lodgepole pine and what it takes to manage it. Second, we have acquired the technology and equipment to be able to manipulate the vegetation and to produce usable products in a cost-efficient manner. Third, we are becoming more aware of economics as a factor in our management decisions. Unfortunately, it is no longer enough to just "do good in the woods." Some of our publics are just not satisfied with that. For a variety of reasons, they expect us to be "more complete managers."

A discussion of acceptable forestry practices on private nonindustrial lands indicates that landowners frequently have two basic guidelines: (1) The treatments prescribed must look good at the time they are completed, and (2) they must not cost any money. The landowners often do not mind accepting a lower profit, they just are not willing to pay something out of their pocket. Long-term forest management is usually a secondary objective at best.

The public forester is also subjected to a lot of pressure to select management options that make it look good or leave it natural. Do we tend to bend and flow with the desires that are currently popular? I submit that all of us have the responsibility to inform our publics of what the realistic range of alternatives and possible effects are. Once these are understood, we should then follow their desires within the constraints of the resource. I hope that we are never accused of being like an electrician who provides a cheap, good-looking wiring job, but the client's house burns down because the electrician did not explain the risks of overloading the circuits.

CONCLUSIONS

We have a species to work with that provides a lot of opportunities and a lot of challenges. Lodgepole pine is intricately linked with a variety of resources and provides us with many products. We must use our professional expertise to describe what the requirements and opportunities are, work with our publics to determine what they desire, and find or develop the equipment and technology to be able to produce it in a cost-effective manner.

I am confident that we are at the stage where we can do these things.

RESOURCE MANAGEMENT ISSUES AND DIRECTION FOR LODGEPOLE PINE FOREST LANDS--INTERMOUNTAIN REGION

Orville E. Engelby

ABSTRACT: Summarizes the management issues and direction currently being developed in the Forest Service Intermountain Region for lodgepole pine forest lands through Land Management Planning efforts. The political process and nature of the "publics" involved have resulted in an apparent polarization of special interest groups. Completion of Land Management Plans will not reconcile all the conflicting interests. Proposed activities in roadless areas not designated wilderness will continue to be an issue. Inventories show that the majority of the commercial lodgepole pine is in the over-80-year age classes.

INTRODUCTION

Management of millions of acres of lodgepole pine in the Intermountain Region of the Forest Service, U.S. Department of Agriculture, is affected by many factors that can be placed into four broad categories:

1. The political process
2. Land management planning or resource allocation
3. Current economic situation
4. Biological factors.

The political process is listed first because it is the arena within which all issues must be addressed. The last two, the economic situation and biological factors, are more critical to lodgepole pine management than to most other timber species because of the small size and low value of the trees, and the nature or condition of our stands.

This paper discusses the broad categories in the order shown. Although many situations appear to be obstacles to sound forest management, generally our expertise has improved over the years and the outlook for better utilization of lodgepole pine in the future is good.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Orville E. Engelby is Assistant Director Timber Management-Silviculture, Intermountain Region, Forest Service, U.S. Department of Agriculture, Ogden, UT.

THE POLITICAL PROCESS

Just as we are in the United States, foresters in other parts of the World are experiencing some difficulty practicing their profession in their respective political arenas. The New Zealand Forest Service was started in 1920 to avoid a predicted domestic wood shortage. Foresters have long heard and read about their great successes with radiata pine. New Zealand is currently exporting 20 percent of its allowable annual cut and would be capable of exporting one-half by 2000. The New Zealand Forest Service was a proud, professional, and successful outfit. It has essentially been disbanded. The radiata pine lands (about 20 percent of forested land) have been put under the Department of Agriculture for management and the native forests (80 percent) have been transferred to the Park Service. Among the reasons given is: "The people did not trust them with all the native forests." In spite of the great success of the New Zealand Forest Service in doing what it was formed to do, its management job has been taken away.

As of last summer Sweden had a complete moratorium on use of herbicides in forestry.

If there is a lesson here, and I suspect there is, it is that we must work within the political system and maintain the public's trust. We have long-standing direction like "the greatest good for the greatest number in the long run." We talk about "the public," and we invite "public involvement" to help us make management decisions. In fact, we are directed by law to have public involvement. The problem is getting and then evaluating the public comments. We worry about the "silent majority" and struggle with what is the overall "public interest." Forest Service Chief Max Peterson recently stated: "One of my failures is that I had hoped to decrease the polarization of the groups that use the National Forests, and that has not been accomplished very well."

Behan (1979) gives us some real food for thought concerning public involvement. He points out the writers of the Constitution were afraid of "majority rule" and designed a fragmented system of political power that prevents mobilizing a majority. Parties emerged to handle elections, and a system of interest group interaction emerged to handle policy formation. He goes on to state that the majority are silent for several reasons: They do not know about the issue at hand; they do not care about the issue at hand; they may know and care about the issue at hand,

but defer to others its resolution; or they may not be affected by the issue at hand.

By virtue of our constitutionally designed system, the knowledgeable, concerned, and affected people in a given issue will appear as conflicting minorities. We should not be surprised or dismayed when all we get from public involvement appears to be conflicting special interest groups.

As foresters, one other point complicates our ability to communicate effectively with "the public." That is the timeframes we think in and talk about. Not only are we a Nation composed of special interest groups, we are conditioned to instant results. Our TV's come on instantly, car radios are wired to the ignition, and we cook with microwaves. Americans are interested in how things affect us right now--not in the long run. We are working with a public that is conditioned to expect instant results, and as foresters we blissfully talk about 100-year-plus rotations.

LAND MANAGEMENT PLANNING

As a result of increasing concerns over management practices in the National Forests (Monongahela, Bitterroot, Wyoming Report, and others), Congress passed the National Forest Management Act of 1976 (NFMA). This act, among other things, mandated that the National Forests complete resource allocation plans, known as Land Management Plans (LMP). We have devoted tremendous amounts of time, energy, and funds to complete these plans. At the same time, we also have the National Environmental Policy Act (NEPA), RARE I (we did not know it was RARE I at the time), RARE II, Ninth Circuit Court Decision, and numerous State wilderness acts passed and not passed, just to name a few of the legislative mandates the National Forest System has been given.

As Forest Plans are completed (with public involvement) and are sent out for public review and comment, the confrontation of conflicting special interest groups seems to be intensified. It has been described as "Utilitarians vs. Naturalists" and "Developers vs. Conservationists," and "the Big Grab for Wild Lands" by U.S. News and World Report (1986). Only time will tell how successful the legislative mandate of NFMA and our Agency efforts to resolve conflicting land use allocations will be. Concerns at the time of NFMA focused on size of clearcuts, lack of regeneration, and appearance of areas following clearcutting. Now they focus on extension of road systems and size of harvesting programs--no longer quality of the work but quantity. This is much more difficult to address.

In the Intermountain Region, the States of Wyoming and Utah both have Wilderness Acts for National Forest System lands. In both States, activities proposed in roadless areas not designated wilderness or for further study are currently under appeal. At the dedication of the Utah wilderness areas with all the appropriate representatives present (agency, timber, grazing, minerals, and wilderness), the Utah Wilderness Society Representative stated: "This is just the beginning."

I believe the cards are on the table, and given our constitution and political processes, and the interests involved, we would be naive to assume that land use plans will make our life simpler. Activities proposed will continue to be appealed by the party that feels wronged. Mark Rey of the National Forest Products Association stated: "The debate will not completely end until the last roadless forest tract is designated for logging or preservation as wilderness."

CURRENT ECONOMIC SITUATION

Current economic conditions also seriously affect lodgepole pine resource management in the Intermountain Region. The introduction to silviculture in a popular textbook (Daniel and others 1979) flatly states: "Forestry must be sound both biologically and economically if it is to really work." Then after covering the effect of "overelaborate management" on private forestry enterprises, the authors go on to state:

> But even in public forestry where strict dollars-and-cents accounting for all tangible and intangible "goods and services" produced by the forest is neither possible nor desirable, there must be some balance in the long run between the cost of forestry and its returns.

This economic approach to public forestry has gotten somewhat more complicated with the current national debt and the emphasis on cash flow.

President Reagan has stated: "Those who receive special benefits and services from the Federal Government should be the ones to bear the costs of those services--not the general taxpayer." At a February 1986 conference on below-cost sales, then Assistant Secretary of Agriculture Peter Myers said: "The real issue is not costs versus revenues, but cost versus public benefits." All these tenets are interesting to contemplate in the current climate of:

1. Below-cost timber sales
2. Cash flow in government
3. Gramm-Rudman-Hollings amendment
4. Multiple-use management of public lands.

Much has been said and written about Forest Service below-cost sales. To me, the debate has produced much more smoke than illumination. Long-term investments in multiple-use forestry can be very difficult to justify when the emphasis is on annual cash flow. Given what I have stated about our political processes and our Forest Service efforts in LMP to reconcile allocation for uses, I submit that the real issue is not below-cost sales at all, but allocation of National Forest

System lands for certain uses. It's not the fact that there are below-cost sales, it's how they affect a special interest right now. Many enjoy the below-cost recreation, hunting, and fishing that the National Forests provide. Last year, the National Forest recreation program cost $100 million and returned $30 million. Sounds to me like a below-cost program. How fair is it for the general taxpayer to pay for the recreation of those who utilize the National Forests for their recreation? How fair or logical is it to judge the timber program by one set of principles and apply another to the recreation program?

The basic issue is not below-cost sales or cash flow. It is how many million acres will be designated and managed for wilderness, and how many will be managed for other uses, such as timber management. Another interesting statistic always comes to mind here: "Only 6 percent of all National Forest recreation occurs in wilderness." This reaffirms what I said earlier about our political system. By its very design and nature it does not concern itself with the majority, but rather the interested and affected conflicting minorities.

BIOLOGICAL FACTORS

In the Intermountain Region, we have a substantial acreage of commercial lodgepole pine type. To get a clear picture of what the resource looks like, I have graphically displayed the commercial lodgepole pine type acres by age groups for four of our National Forests--the Ashley, Wasatch-Cache, Bridger-Teton, and Targhee--with sizable acreages of lodgepole pine.

Because all the inventories are at least a decade old, I added a decade to each age group. I then created the 1- to 10-year age group from each Forest's Silviculture Accomplishment Reports (FY 1976 to 1985). Therefore, the solid bar, 1- to 10-year age group, should be subtracted from the crosshatched bars, but I do not have a good way to display this. For the purpose of visualizing the age class structure of these Forests, it is sufficient to know that the created 1- to 10-year age group had to come out of the total type (crosshatched bars), and probably primarily from the older age groups.

Most of the 27,000 acres of lodgepole over 211 years old in the Ashley National Forest (fig. 1) is at high elevations on the north slope of the Uinta Mountains, where insect and fire intervals are less frequent than at lower elevations. We are currently experiencing a mountain pine beetle epidemic in the Ashley National Forest, and the Forest Service is getting some accelerated harvest under way. The 1984 Insect and Disease Condition Report estimated 2.9 million trees killed by mountain pine beetle in this Forest.

In the Wasatch-Cache National Forest (fig. 2) mountain pine beetle infestations are developing or spreading from the east, in a pattern similar to those in the Ashley National Forest. Most of the lodgepole in this Forest is west of the Ashley on the north slope of the Uinta Mountains. The 1984 Insect and Disease Condition Report estimated 325,000 trees killed by mountain pine beetle in this Forest.

An interesting note in relation to the 71- to 110-year age groups in the Bridger-Teton National

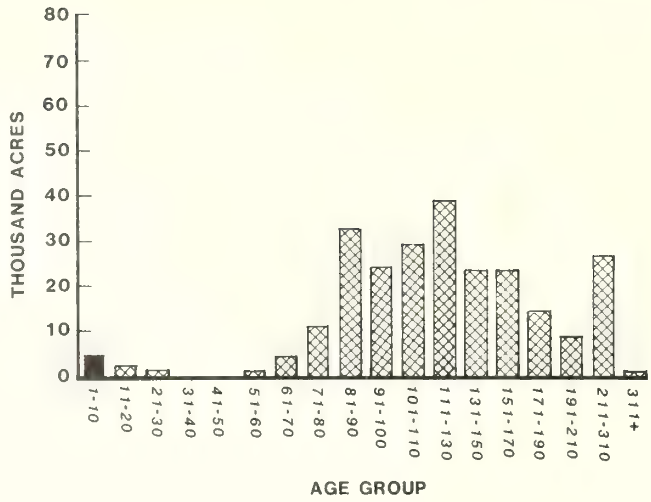

Figure 1--Commercial lodgepole pine acres by age classes--Ashley National Forest. Crosshatched bars represent 240,263 total acres. Eight percent of the lodgepole pine is less than 80 years old, 31 percent is less than 100, and 43 percent is less than 110. About 27,000 acres is over 211 years old.

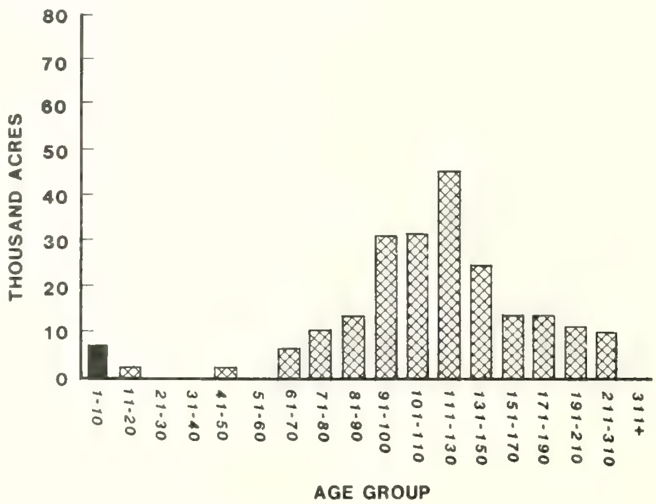

Figure 2-- Commercial lodgepole pine acres by age classes--Wasatch-Cache National Forest. Crosshatched bars represent 212,131 total acres. Sixteen percent of the lodgepole is less than 90 years old and 45 percent is less than 110. Some 9,000 acres is over 211 years old.

Forest (fig. 3) was reported in the Bridger-Teton Activity Review in 1985:

> Fire scar evidence and historical accounts indicate that very large fires took place in the early 1870's, 1879, and 1880. The year 1879 was particularly severe. Much of Jackson Hole and large areas in the Teton Mountains, Island Park, and Yellowstone National Park burned. (Remarks by George Gruell, activity review participant).

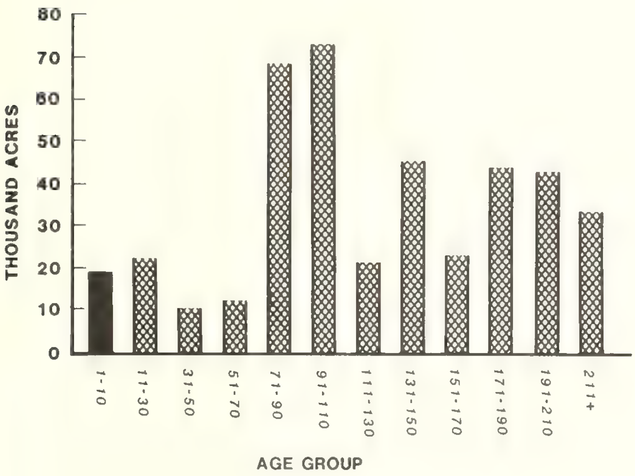

Figure 3--Commercial lodgepole pine acres by age classes--Bridger-Teton National Forest. Crosshatched bars represent 394,635 acres. Twenty-nine percent of the lodgepole is less than 90 years old and 52 percent is less than 130. Some 33,452 acres is over 211 years old.

The Targhee National Forest (fig. 4) shows some interesting differences. The data are from the same sources and displayed in the same manner; however, the inventory portion (the crosshatched bars) should be considered as before the full-scale mountain pine beetle epidemic and accelerated salvage harvesting. The solid bar represents an accelerated reforestation program to keep pace with the salvage harvesting. The 77,000 acres of created 1- to 10-year age group is significant and must be subtracted, mentally at least, from the 403,000 acres represented by the crosshatched age groups.

The Targhee does not have the high-elevation lodgepole type as do the Ashley and Wasatch-Cache National Forests, and the insect and fire frequency is less. Two more decades like the last one and we will have this Forest pretty well reforested. Our direction now is to schedule the Timber Stand Improvement (TSI) program to regulate the harvest in a more orderly manner--move some stands toward their harvest diameter faster (sudden sawlog prescriptions) and hold others back somewhat to regulate and space out future harvest.

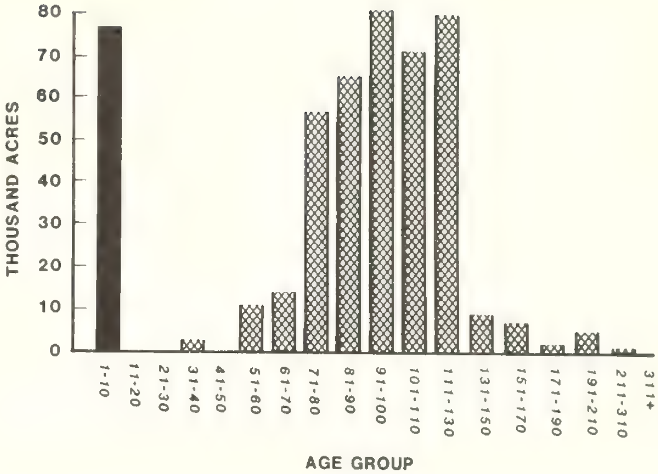

Figure 4--Commercial lodgepole pine acres by age classes--Targhee National Forest. About 77,000 acres is in the created 1- to 10-year age class. Age distribution before the mountain pine beetle epidemic was 6 percent less than 60 years old, 88 percent between 60 and 120, and less than 2 percent over 160.

From these displays of the lodgepole pine resource in four National Forests, we begin to get the picture on age class distribution. Knowing what we know about the silvics of lodgepole pine and recent historical experience in the Targhee National Forest, we can speculate on the future of lodgepole pine in these Forests.

It is apparent in the Intermountain Region that we have substantial acreages of older age class lodgepole pine. It also seems apparent that lodgepole pine (the majority species) has and probably will in the future recycle quite rapidly. The biological factors affecting lodgepole pine forests have been studied and evaluated, and alternatives for the future described and evaluated with at least some degree of scientific soundness. The biological factors are probably the easiest of all to deal with. The problem is dealing with the biology of the species on public lands in the current political arena and current economic situation.

SUMMARY

I was asked to address the "Resource Management Issues and Direction for Lodgepole Pine Forest Lands in the Intermountain Region." Most of my presentation has been on issues. The management direction will come from the LMP's. Project direction is contained in stand- and site-specific prescriptions prepared by certified silviculturists for each timber sale, timber stand improvement, or reforestation proposal. We use the full range of silvicultural treatments from clearcutting to partial cutting and density management. By looking at the issues at this time I may sound pessimistic. I do not intend to

be; we have well-trained silviculturists preparing prescriptions at the sites. The information presented at this symposium will undoubtedly help them greatly with regard to the engineering, utilization, and economic aspects of the lodgepole pine areas we can treat and manage.

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SILVICULTURAL OPTIONS FOR SMALL-STEM LODGEPOLE PINE

Wyman C. Schmidt

ABSTRACT: Lodgepole pine's reproduction habits have perpetuated the species over a wide range of geographic, physiographic, and ecological conditions. However, its propensity to reproduce in abundance leads to severe overstocking problems that are a real challenge to land managers. Silvicultural options for dealing with overstocked lodgepole pine stands are limited more by tradition and economics than by biology. The options include: (1) Do nothing, (2) harvest and start over, (3) intermediate cutting, (4) fertilize, (5) destroy with fire or mechanical means and start over, and (6) combinations of these. Each option has advantages and disadvantages. These vary under the different combinations of stand density, structure, and composition; site quality; age; and social and economic factors that bear on management decisions. Up to now, the most commonly used option is to do nothing, but as demands increase for the resources these stands have to offer, we can expect a shift toward some of the active management options.

INTRODUCTION

Lodgepole pine is often referred to as the "Cinderella" species of the West. This analogy holds very true for many characteristics of this species, particularly when we think of how it was long ignored but is now being recognized and is coming into its own. However, lodgepole pine may not be such a Cinderella after all. Some things have been ignored in accepting the analogy. The innocent lost slipper and the coy wait for Prince Charming may have been a ruse. The facts are, our Cinderella species is actually a seductress that spends her time from youth until old age reproducing, and reproducing, and reproducing.

She pays the price, though. Eventually, her many offspring compete so vigorously for their place in the sun that many die long before youth is past, many become stunted and live well below their potential, and many stay uniformly small. Only a few break out of the mold and excel in their growth and stature.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Wyman C. Schmidt is Project Leader, Subalpine Silviculture, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Bozeman, MT.

That's not a totally happy ending to a tale that normally has Cinderella living happily ever after. But like many other tales it's closer to fact than fiction. What kind of forest problems has this Cinderella of the West given us and what are our silvicultural options for dealing with them? That is the subject of this paper.

THE SCENARIO

Lodgepole pine extends over 60 million acres in the United States and Canada (Wheeler and Critchfield 1985). Most lodgepole pine stands are overstocked, and overstocking has long been considered one of the most vexing problems in managing the species (Alexander 1974; Cole 1975). Densities exceeding 100,000 trees per acre have been observed in young stands and although suppression rapidly reduces their numbers, far too many survive, drastically reducing growth of individuals (Lotan and Perry 1983). In fact, extreme overstocking often results in stagnation--the near complete cessation of height and diameter growth. Bassman's (1985) work with height and live-crown ratios of 20-year-old lodgepole pine stands suggests that stagnation may occur in stands with 10,000 to 20,000 trees per acre.

Lodgepole pine grows under a wide range of geographic, ecologic, edaphic, and physiographic conditions. These factors comprise what we call "site" and provide the first big clues to what must be considered in any silvicultural prescription (Schmidt and Alexander 1985). Site factors combined with damaging agents such as fire, insects, snow, wind, heat, and disease profoundly influence the establishment, stand development, and mortality of lodgepole pine. We must also consider the inherent characteristics of the species such as seed production from both serotinous and nonserotinous cones, seed dispersal, seedling germination and survival characteristics, and a host of other attributes. This series of factors makes up a complex matrix that must be considered in making silvicultural decisions in these forests.

We must look for ways to simplify the process for making logical silvicultural decisions in lodgepole pine forests. In most cases, these forests can be categorized into different classes of age, density, stand structure, composition, and site quality. The variance of each of these provides a broad spectrum of conditions that need to be evaluated before making site-specific silvicultural decisions to meet manage-

ment objectives. I hope this discussion of options will help answer one of the most common questions asked by managers of overstocked lodgepole pine stands--"I inherited these stands, now what can I do with them?"

SILVICULTURAL OPTIONS

At the outset of the research being addressed at this workshop, an effort was made to consider a broad range of utilization and silvicultural research objectives for overstocked lodgepole pine. As described in more detail in other papers given at this workshop, treatments were selected to most closely meet the composite short- and long-term objectives, design criteria, and budget constraints. This boiled down to two levels of intermediate cutting, a do-nothing control, and some clearcuts (harvest and start over) on study areas mostly in Montana, with some in Utah. I want to point out that the terms "thinning" and "intermediate cutting" are often used synonymously, but "intermediate cutting" is used in this paper because of the broad objectives of the studies being reported at this workshop. These treatments cover only some of the viable silviculture and utilization options for immature but overstocked lodgepole pine forests. Utilization options are covered in other workshop papers.

Before the other speakers discuss the results of the studies of the selected treatments, let's examine a somewhat broader range of silvicultural options that might be employed for various stand-site-age condition combinations (fig. 1, 2, 3, 4). Finding the situations where these options can be logically employed is one of the objectives of this workshop and also that of the long-term phase of this study as well as other studies in the lodgepole pine type. Knowing when and how to employ these options is a management decision based largely on biological, social, and economic goals for a given set of forest conditions. The options and their advantages and disadvantages are:

DO NOTHING

Some advantages	Some disadvantages
No investment cost	Potentially productive land produces far less utilizable wood products than it could
May provide some resource values, for example, watershed, wildlife habitat, and esthetics	Foregoes most biological and social resource values
Utilization standards and opportunities may change enough to make these stands economically viable at a later date	Source of insect, disease, and fire problems

Figure 1--Intermediate harvest cuttings can accelerate growth and be a viable option in vigorous lodgepole pine forests that have not been too severely overstocked. Conversely, a "do nothing" policy may best meet overall management objectives on some sites.

Figure 2--Harvesting and starting over with young manageable stands may well be the best silvicultural option in many overstocked or diseased lodgepole pine forests.

Figure 3--Intermediate harvest cuttings can enhance a broad spectrum of resource values in addition to increasing growth of trees to be featured in management.

Figure 4--Fire can play an important role in disposing of slash and preparing the site for regeneration after harvesting or it can be used to convert hopelessly overstocked or diseased lodgepole pine forests to younger manageable stands.

HARVEST AND START OVER

Some advantages	Some disadvantages
Can provide upfront revenue	May have to be done at a deficit
Utilizes some of the resource	May produce little utilizable wood
Provides the opportunity to start over with a young manageable forest	May be difficult to implement in heavily cutover areas because of hydrologic, cover, and other limits
Reduces insect and disease potential	May incur regeneration costs
Creates diverse habitat for wildlife and improves management options for other resources	Markets cannot absorb large increases in supply

INTERMEDIATE CUTTING

Some advantages	Some disadvantages
Utilizes some of the wood resource	May incur net costs
May produce net revenue	Wind and snow damage may occur in reserve stand
Can reduce insect and disease problems	Mechanical damage during thinning operation may result in entrance for disease
Can increase resource values in wildlife habitat, water, and esthetics	Slash can inhibit wildlife movement
Can provide part of an overall strategy to establish age diversity in the type	If improperly done, may increase disease and insect problems
Increases growth of individual trees	In many situations requires expensive hand labor instead of less costly mechanical methods

FERTILIZE

Some advantages	Some disadvantages
Can increase growth of reserve trees in thinned stands	Generally ineffective in unthinned stands
Can enhance understory forage	Incurs costs well before results can be realized
May increase resistance to insects under some site and type of fertilizer combinations	Growth response is usually short-lived
	May attract more insect and animal

	damage under some site and type of fertilizer combinations

DESTROY - PRESCRIBED FIRE

Some advantages	Some disadvantages
Low-cost method of stand conversion	An upfront expense
Can regenerate new stand with manageable composition and density	With poor fire regulation, may just perpetuate the problem by producing another overstocked stand, or it may require the expense of planting or seeding if all seed is burned under the wrong prescription
Closely resembles "nature's method"	Very limited season for prescribed burning on most lodgepole pine sites
By regulating fire intensity, may be able to reduce seed supply and subsequent overstocking	Requires good fire management skills
Usually leaves some shade to enhance seedling survival	If burned too hot on some sites, nutrient capitals, particularly of nitrogen, can be depleted
Reduces insect and disease problems	May have a temporary loss in esthetic values
Usually increases other resource values such as forage	
Can increase availability of nutrients	

DESTROY - MECHANICAL

Some advantages	Some disadvantages
Can regenerate new stand with manageable composition and density	An upfront cost
Have more seasonal latitude in doing the work than with fire	Severely impacts visual quality
Usually increases understory forage	Will usually result in far too many serotinous cones on the ground and as a result too many seedlings
Reduces insect and disease problems	Regulating regeneration composition and density is difficult
	Soil compaction can be a problem on some sites
	Can restrict wildlife movements

COMBINATIONS

Some advantages	Some disadvantages
May be very effective, for example, a combination of thinning and fertilizing or clearcutting to a diameter limit and burning	Increases upfront costs
May be the only feasible solution	May require knowledge and skills not yet available

SOME CONCLUSIONS

With the exception of doing nothing, the options just outlined manipulate stands to meet resource objectives and reduce insect and disease problems. Doing nothing may also meet some objectives, but no manipulations are involved. For every treatment selected, there will be advantages and disadvantages. Those listed here are certainly not exhaustive, but they do provide some idea of the give and take involved with any treatment selected to solve overstocking problems in lodgepole pine stands.

One might argue the case for any of the treatments described here or, for that matter, treatments not mentioned here. What might be a suitable treatment for one site, age, density, and composition combination may be totally unsuitable for some other combination. Even if we had near homogeneous conditions over large areas (and sometimes we do), choosing one uniform treatment for the entire area is usually not a wise biological choice. With a "cornfield management" approach we could mechanize and standardize and vastly improve efficiencies in the whole tree-growing process. Unfortunately, this is not compatible with many resource management objectives. Promoting lack of diversity in size, age, structure, and distribution of stands can lead to serious insect and disease problems. It also leads to reductions in diversity of those ecological niches needed to enhance a wide variety of wildlife, water, esthetic, and other resource values.

Underlying any proposal that involves harvest and utilizing at least some of the stems in overstocked stands, there is a limit to how much the market can absorb. It may be possible to increase markets, but that is something beyond control of forest managers. Also, the current level of operation reflects some intermediate cutting and lots of "do nothing." At the current level of intermediate cutting, the overstocked stands will for the most part not contribute much to offset the projected age class gap 30 to 40 years down the road (Benson 1986). On the bright side, lodgepole pine's response to management or nonmanagement is fairly predictable. This should enhance management by reducing uncertainty and costs.

At this point in time (and I suspect most any point in time), it is hard to reliably predict what mix of timber products, associated resources, and insect and disease reduction methods will be needed in the next century when the results of most of our efforts will be realized.

Like successful investors in the stock market who rely upon diverse investments for protection against uncertainties in the long term, a mixture of silvicultural treatments in a management area is probably the best biological, economic, and social strategy for achieving the resource production needed from lodgepole pine forests in the 21st century. Workshops such as this, that meld the talents of researchers and the practical experiences of forest managers, help define the knowledge gaps and the direction needed to find the slipper that best fits our somewhat tarnished Cinderella species of the West.

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RESEARCH AND DEVELOPMENT EFFORTS IN THE UTILIZATION AND MANAGEMENT OF SMALL-STEM STANDS OF LODGEPOLE PINE

Roland L. Barger

ABSTRACT: Management of natural stands of sub-sawlog-size lodgepole pine has been repeatedly identified by forest managers as a critical problem. As a result, a major Intermountain Station research program effort during the past 5 years has been an evaluation of harvesting, utilization, and silvicultural alternatives in small-stem lodgepole pine. Field investigations have been carried out at sites representing typical natural stands of small-stem lodgepole pine 3 to 7 inches in diameter, geographically dispersed from the Wasatch-Cache to the Lewis and Clark National Forests, and representing a range of stand age from 50 to 120 years and densities of 1,000 to 6,500 green stems per acre. Typical study sites included two levels of intermediate harvest--33 percent and 66 percent basal area reduction prescriptions--and an untreated control. A few included clearcut units. Studies have included evaluations of silvicultural treatments and posttreatment stand response, harvesting practices and costs, product recovery and value, vegetative responses, and economic and management consequences of alternative practices. Results provide a basis from which managers can judge the feasibility and desirability of alternative stand treatments and utilization practices in small lodgepole pine.

INTRODUCTION

In the Interior West, small-stem stands of timber represent perhaps the single most significant opportunity for improving wood resource utilization and forest management. Two distinctly different small-stem stand conditions occur. One is typified by second-growth pole stands of ponderosa pine and Douglas-fir (and occasionally other species not inherently small stemmed when mature). The other, and by far the most extensive, condition involves stands of species that are characteristically small at maturity and may be overstocked and stagnated. The two major species almost universally considered "small timber" are lodgepole pine (fig. 1) and quaking aspen. Stands of lodgepole pine alone occupy more than 12 million acres in the inland West, following the Rocky Mountain chain from Canada south to the higher elevation lands of Utah and Colorado (Barger and Fiedler 1981).

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Roland L. Barger is Program Manager, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT.

Figure 1--Lodgepole pine, an inherently small-stemmed species, occupies more than 12 million acres in the western continental United States.

Two concerns have focused increasing attention on improving harvesting and utilization opportunities for small-stem stands. The first is concern about our continuing ability to meet national demands for wood and wood-based products, especially softwood construction materials. Predictions forecast a growing gap between supply and demand, a situation that can be partially circumvented by placing currently unmanaged timberlands under more intensive management (USDA Forest Service 1977). A second concern is the need to achieve broad resource management and protection objectives relating to

wildlife habitat, watershed management, esthetics, and insect, disease, and fire protection. An urgent concern in lodgepole pine stands is implementation of harvesting and management strategies to reduce the probability of mountain pine beetle epidemics. Improved harvesting opportunities in small-stem stands can contribute to both immediate and long-term timber supply, while facilitating management of other resources as well.

THE RESEARCH AND DEVELOPMENT PROGRAM

In 1979, the Intermountain Research Station initiated a Research and Development Program named STEM (Systems of Timber Utilization for Environmental Management) to address barriers to utilization of small-stem and other marginal stands (Barger 1979). The Program included research in utilization, engineering, and economics in three broad problem areas:

1. Reducing impacts of road access in steep terrain.

2. Developing harvesting and utilization options for small timber and residues.

3. Integrating timber harvesting with multiple-resource management.

In addition, silvicultural and other biological researchers have collaborated with Program researchers in joint efforts to evaluate the biological implications of timber harvesting.

To identify the highest priority research needs relating to utilization of marginal timber resources, an extensive review was conducted involving forest managers across the Northern and Intermountain Regions of the Forest Service. Group discussions and responses identified 26 problem management situations that met the criterion "timbered lands upon which technical and/or economic barriers to utilization constrain the management of both timber and nontimber resources." The 26 problem situations were then assigned priorities based on such factors as urgency, extent, and researchability. In both Regions, the number one priority problem was clearly management of small, overstocked lodgepole pine stands (Barger 1980). Consequently, small-stem lodgepole pine stand management became the focus of a significant part of the Program effort for a 5-year period. It is that body of research, plus directly applicable research on other small-stem timber and areas, that is being reported in this workshop.

SMALL-STEM LODGEPOLE PINE STUDIES

Studies were planned to evaluate an array of silvicultural, harvesting, and utilization alternatives in natural stands of small lodgepole pine. Managers in both Forest Service Regions had expressed a particular interest in management options other than simply clearing by clearcutting, slashing, trampling, or burning. Partial or intermediate harvest cutting offers desirable biological advantages, but raises obvious questions of economic feasibility, residual stand response, stand damage, and management constraints. The research undertaken was in part an effort to shed light on these kinds of questions and concerns.

A principal collaborator with the Program in this research has been the Intermountain Station's Subalpine Forest silviculture unit located in Bozeman, MT. The nature of the questions being addressed necessarily involved close coordination between silviculture and utilization. Stand treatment and evaluation typically involves the following sequence of events:

1. Stand treatment specification (silviculture).

2. Harvesting and utilization operations (utilization).

3. Evaluation of postharvest responses (silviculture and other biological sciences).

Field Study Sites--Much of the research has been carried out at a series of field sites selected to represent as wide an array as possible of stand age, tree size, and density, within natural stands 3 to 7 inches in average diameter at breast height (d.b.h.).

Twenty-five stands were selected with the aid of Forest and District personnel. Basic selection criteria for sample stands included:

1. Stand diameters averaging 6 inches or less (d.b.h.); stand considered precommercial for sawtimber.

2. Site index class SI_{100} = 50 or above.

3. Uniform slope, aspect, and general stand character.

4. Stand age and density generally within the ranges of 50 to 120 years, and 1,000 to 6,500 green stems per acre.

5. Area accessible by existing road, preferably above existing road.

6. Terrain operable with wheeled or tracked harvesting equipment.

With minor exceptions, all selected stands met these criteria. Stand size, age, and density and site are considered the primary biophysical variables likely to influence economic operability and postharvest stand response.

The 25 stands had relatively well-distributed ages and densities, varying from 49 to 122 years in age and 800 to 6,500 green stems per acre (fig. 2). They are located in five National Forests--Deerlodge, Gallatin, Lewis and Clark, Lolo (Montana), and Wasatch-Cache (Utah-Wyoming) (fig. 3).

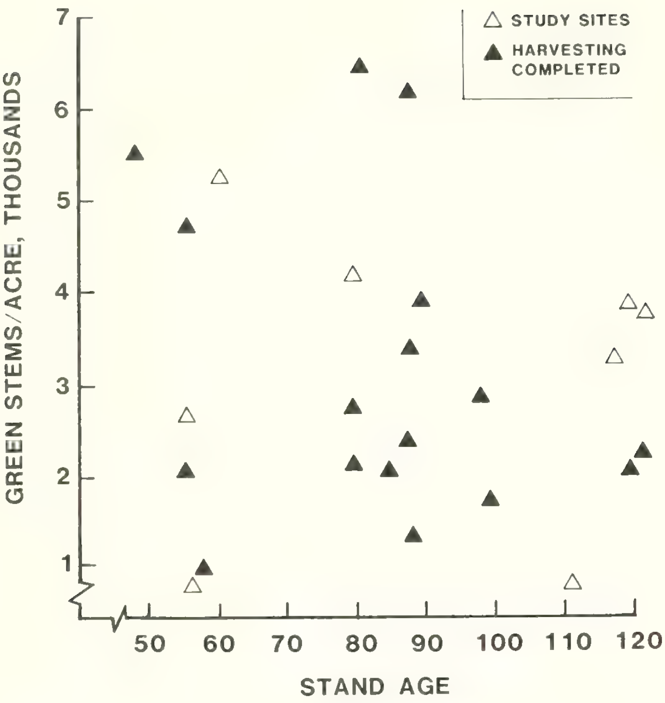

Figure 2--Selected field research sites represented a broad spectrum of stand age and density, with ranges from about 50 to 120 years and 1,000 to 6,500 green stems per acre.

Intensive inventory information was obtained for all selected stands describing the timber resource in detail, as well as understory vegetation and other pertinent biological characteristics of each site. All selected stands are described in detail in an establishment report (USDA Forest Service 1985).

Stand Treatments--Depending upon stand condition and management objectives, stand treatments ranging from clearcutting to intermediate harvest cutting or thinning are all potentially viable options in small lodgepole pine. An objective of this series of studies was to evaluate an array of silvicultural and utilization practices, with special emphasis on intermediate harvest cutting. Treatment options involved adjusting stand densities to different levels. An initial decision had to be made regarding the specific treatment criteria that would be used to specify stand treatments. The following two approaches appeared most viable:

1. Set posttreatment stand densities at specific numbers of trees per acre and remove all but those reserve trees regardless of the original basal area and number of trees. This alternative results in a wide variance of basal area stocking of reserve trees.

2. Set specific levels of basal area reduction based on percent of the unmanaged stand basal area. This alternative results in a wide range of reserve tree numbers per acre.

We chose the latter because we felt it was more compatible with the stand conditions and study objectives. An important distinction to note is that treatments chosen for research purposes are not necessarily valid management prescriptions. Rather, they satisfy experimental design requirements, and ultimately contribute to the development of management prescriptions.

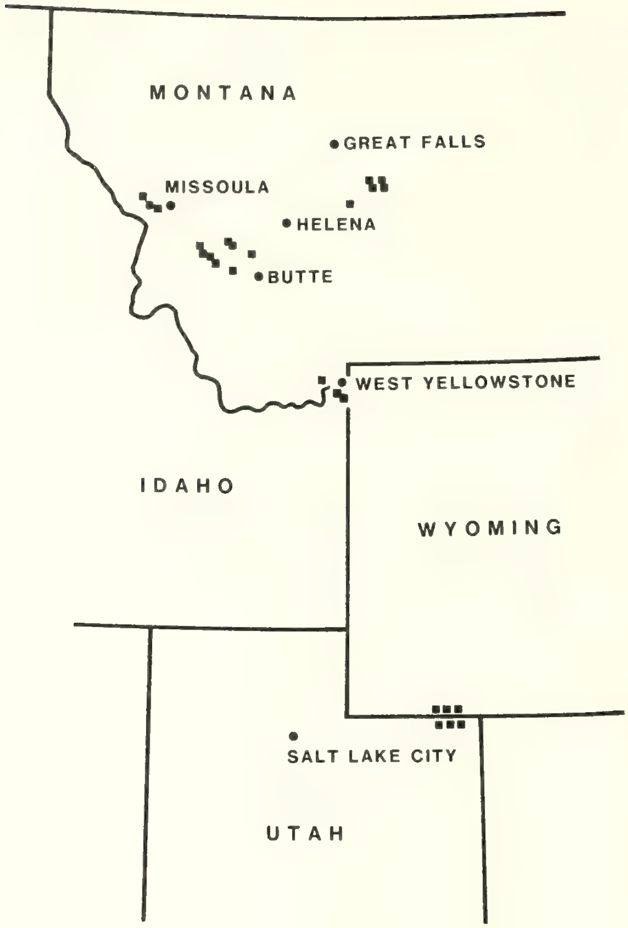

Figure 3--Field research sites were geographically distributed from northern Utah to Montana, with the majority in west-central Montana.

The silvicultural treatments chosen for experimentation included two levels of intermediate cutting. "Light" and "heavy" levels of cutting were defined as reductions in preharvest green stem basal area (BA) of 33 and 66 percent, respectively. The treatments were specified in terms of BA reduction for several reasons:

-- Percentage reduction of pretreatment BA is a relatively easy way to calculate and apply a uniform treatment to widely variable stands.

-- Other research that has been conducted to examine stand responses to treatment (for example, wind damage) has keyed on BA level as a primary independent variable.

-- BA in natural stands is an indicator of site potential or "carrying capacity;" consequently, the level of release provided by intermediate harvest cutting is somewhat proportional to BA reduction.

-- Applying a constant BA reduction to stands differing in average tree size and stand density results in an adjusted residual tree spacing--dense, small-diameter stands are left with relatively close residual stand spacing; larger diameter, more open stands are left with a correspondingly wider spacing.

-- A specific BA reduction prescription provides a constant or benchmark treatment, within which effects of variables such as tree size, age, and stand density can be evaluated. Effects of stand age on residual tree response, for example, must be evaluated in terms of some constant or uniform treatment.

As indicated earlier, not all the stand treatments resulting from this specification would be likely candidates for broad management application. For example, a 33 percent BA reduction in smaller diameter, very dense stands results in a residual stand that is still too closely spaced for management purposes that seek to maximize timber growth. Nevertheless, research objectives are well served by establishing treatments that cover the full array of possibilities, ideally extending beyond the bounds of usual or proposed practice. The application of 33 and 66 percent BA reduction treatments to the wide variety of stands selected resulted in postharvest residual stand spacing ranging from 4 to 17 feet.

Harvesting and utilization specifications for the units were established to attempt to maximize product recovery from cut stems, and to leave a clean, undamaged residual stand for subsequent long-term evaluations of tree response and growth, as well as other biological responses. Harvesting requirements were that all cut trees 3 inches or more in diameter at the stump had to be removed from the unit (older dead excepted). Trees smaller than 3 inches could be left on site, but had to be slashed to lengths of 6 feet or less.

In summary, stand treatments on the study units included:

Stand treatment	Required removal	Residue treatment
1. Light cut (33 percent BA reduction)	Whole-stem, 3 inches plus at stump	Slash on site
2. Heavy cut (66 percent BA reduction)	Whole-stem, 3 inches plus at stump	Slash on site
3. Clearcut (selected units only)	Whole-stem, 3 inches plus at stump	Slash; broadcast burn
4. Control	--	--

Field Operations--Each study stand or unit was established and laid out to include the two levels of intermediate harvest--33 percent and 66 percent BA reduction--plus an untreated control. A few sites, such as the unit illustrated in figure 4, included a clearcut subunit. Most study sites were 5 to 10 acres, with treatment subunits ranging from 1.1 to 3.7 acres and averaging about 2 acres each. Permanently monumented sample points were established in each subunit as a basis for pre- and posttreatment inventory and site evaluation. A number of residual trees around each point are also permanently identified to provide a basis for evaluating response to treatment.

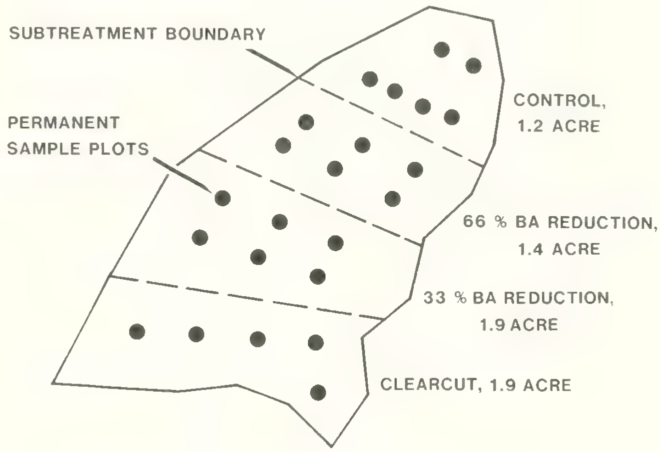

Figure 4--Study units were laid out to include two levels of intermediate harvest and a control subunit. A few also included a clearcut subunit.

Harvesting was carried out with a wide variety of equipment and methods, depending on the capabilities and preferences of successful bidders. Systems ranged from hand operations typical of thinning, to mechanized systems more typical of commercial logging (fig. 5). To avoid masking over or confounding effects of BA reduction, and to maintain maximum comparability among subunits treated by the same treatment, no equipment was allowed in the subunits. Equipment was allowed to enter the stand only on designated skid roads that generally coincided with subunit boundaries. Movement of stems from stump to skid road had to be by hand or by line (winch) skidding. Product recovery was at the option of the contractor, and was encouraged by the requirement that all cut green stems 3 inches and larger be removed from the unit. Actual product recovery varied with market opportunities, distance to buying yards, and the inclination of the contractor.

MAJOR RESEARCH EMPHASIS

The principal areas of research emphasis include silvicultural practices, harvesting and utilization practices, and management consequences of stand treatment. Within each of these broad research areas, several studies have been conducted.

Silvicultural Practices--A major management concern in small lodgepole pine is development of silvicultural treatments that can most effectively promote stand growth and development, and

Figure 5--Harvesting equipment ranged from conventional logging equipment to older nonconventional equipment like the tractor and skidding trailer shown.

reduce susceptibility of stands to insect attack, disease, windthrow, and other such factors. Long-term growth response to intermediate cutting is not presently well established in stands that have long histories of overstocking. Neither are the interactions between growth response and various stand conditions and treatment practices well defined.

Current emphasis in this Country and Canada is directed toward developing long-term management options for lodgepole pine that will break up extensive homogeneous stands and create mosaics of different age classes, species composition, and stand densities. Mountain pine beetle infestations continue to be a primary concern in larger lodgepole pine. An important objective of silvicultural treatments in small-stem stands is to develop stands that are less predisposed to beetle attack. This objective may be achieved in part through developing greater age class diversity among stands, improving growth and vigor, and reducing rotation ages.

This research provided an opportunity to impose alternative intermediate harvesting treatments on small-stem lodgepole pine stands of varying (and known) age and stocking density (fig. 6). Early results reported in this proceedings indicate costs and feasibility of treatment, damage to residual stands from natural causes, and treatment influences relating to other resources. The sites will continue to be monitored and sample trees remeasured periodically for a number of years, to fully evaluate stand and site response to treatment.

Harvesting Feasibility and Product Recovery--Harvesting trees--the removal of all or some part of a stand--is the principal means available to managers to achieve multiresource management objectives on timbered lands. The obvious problem in small-stem stands is the high cost of harvesting numerous small stems with conventional technology, coupled with the typically low value of products recovered. In the kind of stands represented by small lodgepole pine, harvesting costs have historically severely limited stand treatment feasibility. Opportunities exist, however, to improve the situation at both ends of the spectrum. Harvesting technology better suited to small stems is being developed, and markets for small roundwood and wood fiber of any kind are generally improving.

The treated units represented a typical cross section of the harvesting problems and product recovery opportunities inherent in small-stem lodgepole pine stands on gentle terrain. Costs, rates of production, and product recovery were determined for the systems and practices used by the contractors, using both contractor daily records and on-site observations by researchers. Results provide an indication of the economic feasibility of stand treatment and an assessment of the extent to which preharvest stand conditions influence economic feasibility.

Product recovery and associated value is a particularly essential part of any treatment feasibility assessment (fig. 7). A significant research effort went into development and verification of a product prediction model for round-

Figure 6--Pictured is a treatment subunit in which the 66 percent basal area reduction prescription was applied. Stand density was reduced from over 6,000 green stems per acre to 686 stems per acre.

Figure 7--Product recovery from treated stands included post, pole, rail, and "grape-stake" (agricultural and landscaping stake) products.

wood products in lodgepole pine 3 to 7 inches in diameter. The model provides a consistent and unbiased approach to appraising product options and values in stands being considered for treatment. The combination of treatment costs and predicted recoverable product values provides the best approach to identifying those stands that offer the most attractive economic opportunity.

Management Consequences of Harvesting--A major justification for harvesting in presently submarginal stands is to facilitate timber management in the stand, to manage or influence other resources and uses on the site and to reduce susceptibility to insect, disease, and fire damage. Objectives relating to regeneration, improved growth, esthetics, wildlife habitat, watershed management, fire management, insect control and other such concerns often depend on carrying out prescribed harvesting activities. Whether or not such objectives are defined, stand modification through harvesting leads to significant biological and economic consequences for virtually all resources.

The investigation of biological consequences has centered on silvicultural effects (discussed earlier) and on nontimber vegetative responses. Broad resource management implications of harvesting are often either directly or indirectly the result of altering vegetative cover and composition. Program research has been directed toward

identifying and characterizing existing understory plant communities (as the initial basis for vegetative response), developing a model capable of predicting vegetative response and plant community development following harvesting, and relating predicted responses to resource management. The research provides a basis for more effectively assessing the multiresource management consequences of any contemplated stand treatment.

Using harvesting treatments to achieve a combination of timber-oriented and nontimber management objectives raises economic questions of costs incurred and benefits achieved, now and in the future. To make valid decisions among treatment alternatives, managers need to be able to evaluate tradeoffs in economic terms. Of particular importance are identifying economic opportunity costs associated with constraints imposed to protect or enhance nontimber resource values, direct investment costs associated with nontimber management objectives, and the mix of resource values accruing from specific harvesting treatments. For the treatments applied to small-stem lodgepole pine stands, Program research has attempted to identify both the nontimber and timber resource management objectives of concern and define costs and benefits associated with them. Because relative benefits to various nontimber resources change over time (for example, changes in wildlife habitat or visual quality), an analysis of time trends is also an important aspect of this research.

APPLICATION TO THE PROBLEM

This proceedings, and the workshop upon which it is based, are intended to report recent research that can be useful in solving the resource management problem posed by small-stem stands of lodgepole pine. It includes the silvicultural, utilization, and biological response research conducted at the field sites I have described. It also includes discussions of research conducted at other similar sites--the University of Montana's Lubrecht Experimental Forest and Champion Incorporated company lands, for example--and discussions of product, market, and other research not associated with specific field sites.

Information presented here generally does not provide "cookbook" recommendations or final answers to management issues in small lodgepole pine. In the limited time since stand treatment, only initial postharvest effects can be determined with confidence. Rather, the models, analyses, and projections developed and discussed can provide managers with a better understanding of the management implications of any stand treatment, and an improved knowledge of factors critical to stand and site response.

Altogether, participants in this effort over the past 5 years have included Forest Service researchers and land managers, University researchers, industry collaborators, and consulting foresters and researchers. It is our collective hope that the results will provide a basis from which managers can judge the feasibility and both short- and long-term desirability of alternative stand treatments and utilization practices for small lodgepole pine.

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Harvesting Practices and Costs

Chaired by: Michael J. Gonsior

Timber harvesting is the principal means by which multiresource management objectives are pursued on forested lands. Commercial products are recovered and stand and site conditions are altered to meet appropriate resource management prescriptions. Small-stem lodgepole pine often presents severe economic feasibility problems, however, due to inherently high harvesting costs and low product values. Needed are harvesting systems and techniques that can operate more effectively in small-stem stands. Development of new mechanization, prebunching, whole tree handling and processing, and improved system organization are among the approaches that may improve efficiency. Discussed in this section are some of the systems and practices that can contribute to improved harvesting feasibility in small lodgepole pine.

TIMBER HARVESTING FEASIBILITY IN SMALL-STEM LODGEPOLE PINE

Charles H. Hawkins III

ABSTRACT: Management of small-stem (averaging less than 6 inches in diameter at breast height) lodgepole pine is a major problem in the Rocky Mountain West. Costs of desired silvicultural treatments in these stands generally exceed the value of recovered products. Improved harvesting techniques and product utilization would enable forest managers to offset larger portions of stand treatment costs. Thus, more of this immense resource could be brought under management with the limited funds available.

INTRODUCTION

This study was designed to evaluate opportunities for cost reduction and revenue generation in harvesting small-stem lodgepole pine. Operations on 11 study units were assessed for productivity, cost, and product recovery. It was apparent that the contractor's experience, skill, organization, and motivation had more bearing on productivity than did the specific harvesting system. The most significant variables affecting treatment costs were found to be level of basal area reduction, number of trees designated for cutting that were 3 inches or larger, and intensity of product salvage and manufacture. Product recovery value was also strongly influenced by these variables, as well as by local markets.

Study results indicate that investments should be concentrated on the best sites where a combination of tree density, size, and form result in highest predictions of product value. Tree-length harvesting and marketing appears to be the most cost-effective method of operation. Cost reduction and revenue generation can be improved by contractors who refine their basic technical, management, and marketing skills.

BACKGROUND AND OBJECTIVES

Much of the Rocky Mountain West is forested with overstocked stands of small-stem lodgepole pine. These present a major problem for resource managers. Because of high harvesting costs and low product values timber harvest returns alone can seldom be relied upon to cover the cost of desired silvicultural treatment.

The studies undertaken were principally intended to identify opportunities for reducing harvest costs and increasing product revenues. While admitting that few stands of small-stem lodgepole pine can generate sufficient revenue to pay for intensive silvicultural treatment, and it may not be feasible to treat many stands under any circumstances, we hoped to gain some practical insights that would enable forest managers to treat slightly submarginal stands at reduced net costs. We wanted to determine how various preharvest stand conditions, as well as specified treatment variables, affected harvesting productivity and cost. We also wanted to compare stands in terms of treatment feasibility, to discover the most productive harvesting systems and techniques, and to assess the potential products and values that can be recovered from treated stands.

STUDY SITES

As part of a larger interdisciplinary study, 25 study sites were established across the Forest Service Northern and Intermountain Regions. Ostensibly, these study sites described the range of small-stem lodgepole pine stand conditions in the Intermountain West. Stands selected portrayed a wide range of stocking densities, ages, site indices, and tree sizes, and stand compositions of saplings and poles with average breast-height diameters well below 6 inches. All study sites were accessible by existing roads, situated on uniform slopes, and operable with conventional wheel or track harvesting equipment. Figure 1 shows a typical stand before harvest.

Figure 1--Typical study site preharvesting stand conditions.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Charles H. Hawkins III is a consulting forester with Rocky Mountain Forestry, White Sulphur Springs, MT.

Harvesting component costs and actual product recovery, as well as predicted product recovery, were analyzed on 11 of these study units in the Northern Region. These 11 units included 25 treatment subunits. Treatments on the other 14 study units were either not completed or so compromised that the results could not be used for analysis of harvesting and utilization alternatives. Table 1 compares preharvest stand conditions for the 25 treatment subunits included in this analysis.

All 11 study sites are located in Montana. Rattling Gulch and the three Corduroy units are in the Upper Willow Creek drainage, 23 to 26 miles northwest of Philipsburg. Echo Lake is about 2 miles north of Georgetown Lake. Ballard Hill North is some 10 miles south of Gold Creek. All six of these units are in the Deerlodge National Forest.

Four study sites are 30 to 60 miles north of White Sulphur Springs in the Lewis and Clark National Forest. Currie Coulee North and the two Dry Fork units are 3 to 4 miles east of Monarc in the Dry Fork drainage. Wet Park is about 20 miles southwest of Neihart near Kings Hill Pass. South Flat lies 2 miles south of West Yellowstone in the Gallatin National Forest.

Detailed descriptions of all study site locations and conditions, along with some postharvest information and much additional pertinent data, can be found in the STEM Program Establishment Report "Harvesting and Silvicultural Alternatives in Small-Stem Lodgepole Pine Stands" (Barger 1985).

Table 1--Comparison of stand conditions (on a per-acre basis)

Treatment unit and subunit	Subunit area	Stand age	Site index	Stems /acre	BA /acre	Average d.b.h.	Average slope
	Acres	Years	Index	No.	Ft^2	Inches	Pct
Rattling Gu T-1	1.33	59	83	1,086	144	4.60	5
Rattling Gu T-2	1.47	59	83	863	135	4.97	5
Corduroy E T-1	1.86	85	78	2,875	237	3.66	8
Corduroy E T-2	1.39	85	78	3,058	214	3.33	8
Corduroy E T-3	1.86	85	78	3,240	228	3.31	8
Corduroy W T-1	1.76	88	69	5,444	221	2.54	8
Corduroy W T-2	1.55	88	69	3,851	233	3.08	8
Corduroy N T-1	3.66	86	70	9,264	221	1.94	8
Corduroy N T-2	3.19	86	70	9,400	250	2.04	8
Echo Lake T-1	2.12	88	70	9,317	281	2.10	20
Echo Lake T-2	2.53	88	70	8,329	267	2.19	20
Currie N T-1	1.18	54	82	3,140	169	2.90	30
Currie N T-2	1.29	54	82	5,280	183	2.23	30
Dry Fork E T-1	2.24	57	77	7,277	187	1.93	22
Dry Fork E T-2	2.16	57	77	5,056	177	2.32	22
Dry Fork W T-1	1.26	56	77	5,334	153	2.05	22
Dry Fork W T-2	1.19	56	77	8,354	174	1.71	22
Wet Park T-1	1.52	88	66	6,885	273	2.48	2
Wet Park T-2	1.38	88	66	4,689	300	3.14	2
Wet Park T-3	.99	88	66	4,200	248	3.02	2
Ballard N T-1	1.80	80	94	3,265	306	3.78	20
Ballard N T-2	1.55	80	94	4,271	357	3.57	20
South Flat T-1	1.56	89	63	3,436	227	3.26	5
South Flat T-2	1.35	89	63	3,150	219	3.34	5
South Flat T-3	1.29	89	63	4,250	159	2.48	5

TREATMENT SPECIFICATIONS

Treatments were specified to meet multidisciplinary research objectives. For harvesting operations, requirements were quite demanding and restrictive. It is important to remember this when considering the costs incurred.

To provide a range of treatments, each study unit was divided into several subunits, ranging in size from 0.99 to 3.66 acres. Each unit included subunits targeted for 33 and 66 percent basal area reduction. These reductions resulted in an array of leave-tree spacings ranging from 4.0 to 17.5 feet. In some cases, a clearcut subunit also was included. All study sites had an uncut control area.

In partial-cut subunits, the operator was instructed to select the largest, best formed, and healthiest trees that conformed to a specified leave-tree spacing guide. Only a small sample area was premarked for the operator.

All cut trees 3.0 inches in diameter or larger at stump height were required to be removed from the unit. Whole-tree (including top) removal was required to simulate salvage of all potentially merchantable stems and to satisfy slash disposal objectives. Actual salvage of salable products was encouraged, but not mandatory. Trees and parts of trees not salvaged were bucked into 6-foot maximum lengths and piled outside the unit boundary. Cut trees smaller than 3.0 inches in diameter at stump height were slashed into 6-foot maximum lengths and left in place on site. Figures 2 and 3 show postharvest stands where basal area was reduced 33 and 66 percent.

Figure 2--Typical postharvest stand condition after 33 percent basal area reduction.

Neither road construction nor operation of wheel or track vehicles was permitted within the treatment subunit. But stump road and skid trail construction was permitted as necessary to access all unit perimeters. Road and trail development was also allowed along the common internal boundaries of adjacent subunits.

Figure 3--Typical postharvest stand condition after 66 percent basal area reduction.

Harvesting requirements and operating constraints were strictly enforced. This ensured the consistent treatment necessary for concurrent and subsequent multidisciplinary studies on these sites. Some notable exceptions which were allowed were:

> On the Wet Park clearcut (T-3), the contractor was permitted to use a small crawler tractor equipped with a tree shear for felling and skidding.

> To compensate for steep slopes (exceeding 30 percent) and excessive forwarding distance (up to 800 feet) on Currie Coulee North, the contractor was permitted to construct a skid trail through the unit. The crawler-mounted shear was used to cut right-of-way on this trail.

Table 2 compares the treatment specifications for all 25 subunits.

HARVESTING SYSTEMS AND METHODS

Contractors working under service contracts awarded through competitive bidding performed all treatments. Within limits of treatment specifications, contractors were permitted total latitude in choice of harvesting systems, equipment, and salvage and sale of merchantable products. Work began in fall 1982 and progressed spasmodically through the 1983 and 1984 field seasons.

Because of the variety of site conditions and locations, we anticipated that a wide variety of innovative methods and equipment would be employed and that a broad array of products would be salvaged. But in fact, all systems were quite conventional and labor-intensive, and salvage was generally limited to an assortment of post and pole products. Figure 4 shows equipment used in a typical hand-labor harvesting operation.

Table 2--Comparison of stand treatments (on a per-acre basis)

Treatment unit and subunit		Residual[1] Spacing	Stems	BA removed	Stems cut	Stems cut and removed	
		Feet	No.	Pct	- - Number - -		Ft^3
Rattling Gu	T-1	11.00	400	39	686	468	1,188
Rattling Gu	T-2	17.50	241	48	622	468	1,513
Corduroy E	T-1	6.50	1,091	35	1,784	676	1,319
Corduroy E	T-2	11.00	475	65	2,583	1,208	2,666
Corduroy E	T-3	--	0	100	3,240	1,620	4,877
Corduroy W	T-1	6.00	1,943	34	3,501	328	453
Corduroy W	T-2	10.50	614	60	3,237	1,112	2,112
Corduroy N	T-1	4.00	3,264	32	6,000	0	0
Corduroy N	T-2	7.50	1,186	66	8,214	656	793
Echo Lake	T-1	5.00	1,601	58	7,716	951	1,668
Echo Lake	T-2	8.50	686	79	7,643	1,443	2,482
Currie N	T-1	6.50	930	48	2,210	600	1,017
Currie N	T-2	11.50	350	81	4,930	1,110	1,857
Dry Fork E	T-1	5.50	1,327	57	5,950	475	616
Dry Fork E	T-2	9.50	544	77	4,512	1,034	1,452
Dry Fork W	T-1	5.50	1,578	42	3,756	212	254
Dry Fork W	T-2	9.50	600	78	7,754	566	658
Wet Park	T-1	7.00	701	78	6,184	1,441	2,434
Wet Park	T-2	12.00	315	88	4,374	1,887	4,614
Wet Park	T-3	--	0	100	4,200	1,925	4,138
Ballard N	T-1	6.50	1,149	31	2,116	815	1,612
Ballard N	T-2	11.00	250	83	4,021	2,085	6,983
South Flat	T-1	6.00	1,036	42	2,400	757	1,178
South Flat	T-2	10.50	429	71	2,721	1,271	2,724
South Flat	T-3	--	0	100	4,250	1,125	1,007

[1]Target spacing, actual stems.

Figure 4--Equipment used in typical hand-labor harvesting operation.

Haul Roads, Skid Trails, and Landings

Our intent was to locate study sites reasonably close to existing haul roads. Two subunits (Rattling Gulch T-1 and Echo Lake T-2) were adjacent to such roads. The remainder were accessed by opening old spurs or building minimum-standard stump roads and skid trails. Operators typically constructed trails along three quarters of the subunit perimeter and forwarded merchantable products about 400 feet to centralized landings or roadsides.

Stump roads and skid trails were cleared with crawlers, skidders, or hand labor as available. Merchantable products were usually salvaged from some of the larger trees and residual slash was piled along the right-of-way. The character of the road and trail clearing operations tended to parallel the methods used within adjacent treatment units. Landings were located in natural or

existing openings and seldom caused much additional clearing.

Harvesting Systems and Methods

Following are cursory descriptions of the two prevalent systems used by the several contractors. These can be categorized broadly as product-length and tree-length operations.

Product-Length Operations--These were used at Rattling Gulch, Corduroy East, and Corduroy West, Corduroy North (all operated by one prime contractor and one subcontractor), and Echo Lake, which was operated by a second contractor. These operations were well organized and reflected an air of knowledge, experience, and efficiency by contractor personnel.

Crews consisted of one man working alone or of two to four people working in concert. Leave-tree selection and product manufacture was always done by the faller. Bucking was always done directly after felling and merchantable products, nonmerchantable material (slashed to 6-foot lengths), and tree tops were immediately hand-carried to the unit boundary. Salvaged pieces were piled by product classification and nonmerchantable material was piled for burning. Trees smaller than 3.0 inches at stump height were slashed into 6-foot or shorter lengths directly after felling and left on the site. The system seldom varied, although the crews occasionally prethinned small trees in the denser stands and sometimes deferred slashing small felled trees until a later time.

From the unit boundary, merchantable products were forwarded to a centralized landing or roadside where they were usually cold-decked for future loading and hauling to market. Hot-loading was rare. The contractors at the Rattling Gulch and Corduroy units used an antiquated farm tractor and homemade trailer for forwarding. At Echo Lake, the contractor used a vintage small crawler tractor. This old equipment was in good repair and was generally available when needed for limited light-duty use. Products were loaded by hand and hauled to market on small flatbed or pickup trucks.

Tree-Length Operations--This was the principal method used over most of the area at Currie Coulee North, Dry Fork East, Dry Fork West, and Wet Park (all of which were operated by the same contractor), as well as at Ballard Hill North and South Flat, which were operated by another contractor.

These operations were characterized essentially by tree-length removal from the unit and forwarding to centralized landings where products were bucked and nonmerchantable material was piled. But specific procedures varied quite radically as the contractors progressed and experimented with their harvesting systems. Occasionally, the system was completely compromised and more closely resembled the product-length methods. Crews at these units tended to be larger, less experienced, and poorly organized. Most of the time, trees smaller than 3.0 inches were prethinned to some extent with slashing deferred until all other work was completed. Leave-tree decisions were made by the fallers at Ballard Hill North and South Flat. At Currie Coulee North, Dry Fork East, Dry Fork West, and Wet Park leave-trees were premarked by the contractor. Trees 3.0 inches and larger were felled directionally and either winched or hand-dragged to the subunit boundary. Prebunching by hand was found to improve the productivity of equipment used for winching.

Small skidders and crawlers were used to winch trees from the units and forward them to landings. They were also used for road, trail, and landing construction, for maintenance of these facilities, and for slash piling. All equipment tended to be grossly underutilized in terms of scheduled time, idling time, and payload capacity. Much of this equipment was in poor repair and often unavailable for work when needed.

Trees removed from the units were disposed of in several ways. Methods ranged from cold-decking in tree-length form for later salvage, to immediate manufacture and cold-decking in product form, to occasional hot-logging, in which products were manufactured and loaded as soon as the trees reached the landing. Where merchantable products were not salvaged, trees removed were usually slashed and piled at the unit boundary. Specific methods tended to vary radically both between and within treatment subunits.

At the Dry Fork and Wet Park units, merchantable products were loaded with a small wheel-driven front-end loader and hauled on a flatbed truck. (No products were salvaged from the Dry Fork T-1 subunits or from Currie Coulee North.) Conventional self-loading log trucks hauled a few small sawlogs and houselogs from Ballard Hill North and South Flat; but the majority of merchantable material from these units was hand loaded and hauled on light-duty short-log or small flatbed trucks. Table 3 summarizes the labor and equipment hours expended at each of the 25 subunits.

DATA COLLECTION

Production summaries were based on a combination of operator reporting, field verification, and preharvest and postharvest inventories. Inventory work was done by Intermountain Research Station field crews and processed by Station personnel in conjunction with concurrent studies.

Stump road and skid trail construction time and right-of-way product recovery data were compiled. But only data from those portions actually within the unit boundaries were included in this analysis. Data from roads and trails along common internal boundaries were divided evenly between the adjacent subunits.

Because of the inherent errors, omissions, and inconsistencies of operator reporting, and the variation encountered in stand and product sampling, these production results are presented with some reservation. Although this information is

Table 3--Labor and equipment time (on a per-acre basis)

Treatment unit and subunit		Labor		Equipment		Total[1]	
		Cut	Remove	Cut	Remove	Labor	Equipment
		Hours					
Rattling Gu	T-1	42	60	42	0	102	42
Rattling Gu	T-2	40	61	40	3	101	43
Corduroy E	T-1	26	30	26	3	56	29
Corduroy E	T-2	55	59	55	1	114	56
Corduroy E	T-3	85	125	85	21	210	106
Corduroy W	T-1	46	29	46	0	75	46
Corduroy W	T-2	85	99	85	5	184	90
Corduroy N	T-1	31	0	31	0	31	31
Corduroy N	T-2	29	30	29	1	59	30
Echo Lake	T-1	74	52	74	0	126	74
Echo Lake	T-2	125	85	125	0	210	125
Currie N	T-1	59	28	45	0	87	45
Currie N	T-2	59	29	46	0	88	46
Dry Fork E	T-1	48	30	48	3	78	51
Dry Fork E	T-2	112	63	99	27	175	126
Dry Fork W	T-1	69	25	50	13	94	63
Dry Fork W	T-2	99	126	79	47	225	126
Wet Park	T-1	55	16	45	11	71	56
Wet Park	T-2	118	162	102	72	280	174
Wet Park	T-3	171	67	172	61	238	233
Ballard N	T-1	40	58	40	13	98	53
Ballard N	T-2	52	46	52	46	98	98
South Flat	T-1	94	108	93	10	202	103
South Flat	T-2	118	111	117	7	229	124
South Flat	T-3	160	259	160	77	419	237

[1]Includes cutting, removal, slash treatment, and forwarding time; does not include access road or landing construction time.

less than exact, it still provides reasonable approximations that are adequate for comparative purposes.

LABOR AND EQUIPMENT COST BASIS

To provide a consistent basis for comparing relative costs among treatment subunits, harvesting systems, and operators, standard labor and equipment rates were applied to reported operating time. Parallel analyses were made using two separate sets of assumptions.

Table 4 shows the labor and equipment rate assumptions used in the first analysis. They typify rates paid and costs incurred by the contractors who participated in this study. These rates were formulated by consensus of several researchers who are studying small-stem harvesting costs.

A second set of assumptions is shown in table 5. These are adapted from the Forest Service Manual timber sale appraisal section for the Northern Region. They indicate cost allowances that might be required to attract high-volume contractors for extensive stand treatments. A concomitant assumption might be that higher labor and equipment rates would engender corresponding productivity increases. But this hypothesis has not been tested and is not considered in the analysis.

FELLING AND SLASHING COSTS

Table 6 summarizes costs of felling and slashing trees required to be cut. These costs are based on labor and equipment time shown in table 3 and on labor and equipment rates shown in table 4. They incorporate all costs incurred in felling and slashing as well as the additional costs of limbing, measuring, and bucking engendered by optional salvage of salable products. Such functions were charged to cutting (felling and slashing) whether they were performed at the stump, adjacent unit boundary, or a remote landing.

Felling and slashing costs shown in table 6 indicate what a forest manager might have to pay for comparable treatments in similar stands,

Table 4--Labor and equipment rates (on a per-hour basis)[1]

Item	Base	Pay-roll	Over-head	Total
	- - - - - Dollars - - - - -			
Labor:				
Sawyer (w/o saw)	6.00	2.00	0.72	8.72
Equipment operator	6.00	2.00	.72	8.72
General laborer	6.00	2.00	.72	8.72
Equipment:				
Chainsaw	1.50	--	--	1.50
Skidders and tractors	12.00	--	--	12.00

[1]Based on consensus of several researchers studying small-stem harvesting costs.

Table 5--Alternative labor and equipment rates (on a per-hour basis)[1]

Item	Base	Pay-roll	Over-head	Total
	- - - - - Dollars - - - - -			
Labor:				
Sawyer (w/o saw)	9.08	3.00	1.45	13.53
Equipment operator	8.95	2.95	1.43	13.33
General laborer	8.95	2.95	1.43	13.33
Equipment:				
Chainsaw	2.27	--	--	2.27
Skidders and tractors	20.94	--	--	20.94

[1]Adapted from Forest Service Manual 8/82 R-1 (Northern Region) Supplement 293.

assuming all cut trees can be slashed and left in place. Actually, the manager might expect to perform such treatments at slightly lower costs than those shown here. This is because our study included those additional cutting costs implicitly associated with required removal and optional salvage (for example, directional felling, limbing, measuring, and bucking).

ADDED COST OF REQUIRED REMOVAL

In table 7, the cost of requiring that all cut trees 3.0 inches and larger be removed from units is added to cutting costs. Removal costs include such activities as piling and prebunching, hand carrying and dragging, choker setting and winching, skidding and forwarding, product sorting and decking, and slash piling. As with cutting costs, such functions were charged to removal cost regardless of point of performance.

Table 6--Costs of felling and slashing (on a per-acre basis)[1]

Treatment unit and subunit		Labor	Equipment	Total
		- - - - - Dollars - - - - -		
Rattling Gu	T-1	366	63	429
Rattling Gu	T-2	349	60	409
Corduroy E	T-1	227	39	266
Corduroy E	T-2	480	83	562
Corduroy E	T-3	741	128	869
Corduroy W	T-1	401	69	470
Corduroy W	T-2	741	128	869
Corduroy N	T-1	270	47	317
Corduroy N	T-2	253	44	296
Echo Lake	T-1	645	111	756
Echo Lake	T-2	1,090	188	1,278
Currie N	T-1	514	139	653
Currie N	T-2	514	200	714
Dry Fork E	T-1	419	72	491
Dry Fork E	T-2	977	149	1,125
Dry Fork W	T-1	602	75	677
Dry Fork W	T-2	863	119	982
Wet Park	T-1	480	92	572
Wet Park	T-2	1,029	214	1,243
Wet Park	T-3	1,491	1,179	2,670
Ballard N	T-1	349	60	409
Ballard N	T-2	453	78	531
South Flat	T-1	820	140	959
South Flat	T-2	1,029	176	1,204
South Flat	T-3	1,395	240	1,635

[1]Includes all costs of felling and slashing, plus the costs of limbing, measuring, and bucking optional salvaged products.

Table 8 summarizes cutting and removal costs in terms of the higher alternative labor and equipment rates shown in table 5.

Removal costs shown in tables 7 and 8 do not indicate what an operator might expect to spend on product recovery under conventional treatment prescriptions. This is because our requirements included stringent silvicultural study constraints such as removal of nonmerchantable material and exclusion of machinery from the units. Removal costs and total costs summarized here are intended to illustrate relative results under this set of research requirements. Under more typical operating circumstances--where the contractor need only remove merchantable material and where equipment can be operated throughout the unit (or at least on more closely spaced trails)--one would expect the incremental costs of product removal to be substantially lower than those in our study.

Table 7--Costs of total stand treatment (on a per-acre basis)

Treatment unit and subunit		Labor		Equipment		Total		Total		Grand total[1]
		Cut	Remove	Cut	Remove	Labor	Equipment	Cut	Remove	
		Dollars								
Rattling Gu	T-1	366	523	63	0	889	63	429	523	952
Rattling Gu	T-2	349	532	60	36	881	96	409	568	977
Corduroy E	T-1	227	262	39	36	488	75	266	298	563
Corduroy E	T-2	480	514	83	12	994	95	562	526	1,089
Corduroy E	T-3	741	1,090	128	252	1,831	380	869	1,342	2,211
Corduroy W	T-1	401	253	69	0	654	69	470	253	723
Corduroy W	T-2	741	863	128	60	1,604	188	869	923	1,792
Corduroy N	T-1	270	0	47	0	270	47	317	0	317
Corduroy N	T-2	253	262	44	12	514	56	296	274	570
Echo Lake	T-1	645	453	111	0	1,099	111	756	453	1,210
Echo Lake	T-2	1,090	741	188	0	1,831	188	1,278	741	2,019
Currie N	T-1	514	244	139	0	759	139	653	244	898
Currie N	T-2	514	253	200	0	767	200	714	253	967
Dry Fork E	T-1	419	262	72	36	680	108	491	298	788
Dry Fork E	T-2	977	549	149	324	1,526	473	1,125	873	1,999
Dry Fork W	T-1	602	218	75	156	820	231	677	374	1,051
Dry Fork W	T-2	863	1,099	119	564	1,962	683	982	1,663	2,645
Wet Park	T-1	480	140	92	132	619	224	572	272	843
Wet Park	T-2	1,029	1,413	214	864	2,442	1,078	1,243	2,277	3,520
Wet Park	T-3	1,491	584	1,179	732	2,075	1,911	2,670	1,316	3,986
Ballard N	T-1	349	506	60	156	855	216	409	662	1,071
Ballard N	T-2	453	401	78	552	855	630	531	953	1,485
South Flat	T-1	820	944	140	120	1,764	260	959	1,064	2,023
South Flat	T-2	1,029	968	176	84	1,997	260	1,204	1,052	2,256
South Flat	T-3	1,395	2,258	240	924	3,654	1,164	1,635	3,182	4,818

[1]Includes cutting, removal, slash treatment, forwarding, and optional salvage costs; does not include access road or landing construction costs.

Table 8--Costs of total stand treatment using higher alternative costs from table 5 (on a per-acre basis)

Treatment unit and subunit		Labor		Equipment		Total		Total		Grand total[1]
		Cut	Remove	Cut	Remove	Labor	Equipment	Cut	Remove	
		Dollars								
Rattling Gu	T-1	570	802	96	0	1,372	96	666	802	1,467
Rattling Gu	T-2	543	807	91	57	1,350	148	634	864	1,498
Corduroy E	T-1	356	396	60	68	752	128	416	464	878
Corduroy E	T-2	740	786	124	15	1,526	139	864	801	1,665
Corduroy E	T-3	1,157	1,663	194	439	2,820	633	1,351	2,102	3,453
Corduroy W	T-1	623	386	104	0	1,009	104	727	386	1,113
Corduroy W	T-2	1,144	1,316	192	95	2,460	287	1,336	1,411	2,747
Corduroy N	T-1	414	0	69	0	414	69	483	0	483
Corduroy N	T-2	390	401	65	13	791	78	455	414	870
Echo Lake	T-1	998	694	167	0	1,692	167	1,165	694	1,859
Echo Lake	T-2	1,690	1,132	284	0	2,822	284	1,974	1,132	3,106
Currie N	T-1	794	367	229	0	1,161	229	1,023	367	1,390
Currie N	T-2	794	393	337	0	1,187	337	1,131	393	1,524
Dry Fork E	T-1	646	405	108	66	1,051	174	754	471	1,225
Dry Fork E	T-2	1,740	839	225	567	2,579	792	1,965	1,406	3,371
Dry Fork W	T-1	934	336	114	266	1,270	380	1,048	602	1,652
Dry Fork W	T-2	1,342	1,680	179	985	3,022	1,164	1,521	2,665	4,187
Wet Park	T-1	748	210	200	220	958	420	948	430	1,379
Wet Park	T-2	1,598	2,154	340	1,502	3,752	1,842	1,938	3,656	5,595
Wet Park	T-3	2,310	889	2,028	1,269	3,199	3,297	4,338	2,158	6,596
Ballard N	T-1	541	770	91	268	1,311	359	632	1,038	1,670
Ballard N	T-2	698	619	117	973	1,317	1,090	815	1,592	2,407
South Flat	T-1	1,274	1,446	210	201	2,720	411	1,484	1,647	3,132
South Flat	T-2	1,595	1,482	265	147	3,077	412	1,860	1,629	3,490
South Flat	T-3	2,168	3,447	364	1,607	5,615	1,971	2,532	5,054	7,585

[1]Includes cutting, removal, slash treatment, forwarding, and optional salvage costs; does not include access road or landing construction costs.

INFLUENCE OF STAND, TREATMENT, AND HARVESTING VARIABLES

Our field observations and subjective analysis of production data inferred that individual subunit costs might be affected by three interrelated groups of variables:

1. Stand conditions such as tree density, stem size, and ground slope.

2. Treatment specifications including subunit size and shape, basal area reduction, stems cut and removed, and leave-tree spacing.

3. Harvest system design and technique; for example, methods, equipment, forwarding distance, salvage intensity, degree of product manufacture, and operator efficiency.

To see how they influenced total treatment cost, we tested many of these variables in a stepwise multiple regression analysis. Results suggested that only two variables were significant. These were basal area reduction and number of stems 3.0 inches and larger cut and removed. But statistical validity was doubtful due to the number of variables tested.

We also tested several variables by simple two-variable regression analysis to see how they influenced felling and slashing cost. As expected, basal area reduction proved again to have a strong bearing on cost. Also as expected, the importance of the number of stems 3.0 inches and larger cut and removed was proved again. These trends are shown in figures 5 and 6. Analysis of other variables (such as preharvest stems per acre, total trees cut, and average d.b.h.) indicated no significant statistical relationship to felling and slashing cost. Although the number of stems cut must influence cost, the statistical relationship is masked by the large proportion of very small stems (less than 2 inches d.b.h.) that require little effort to cut.

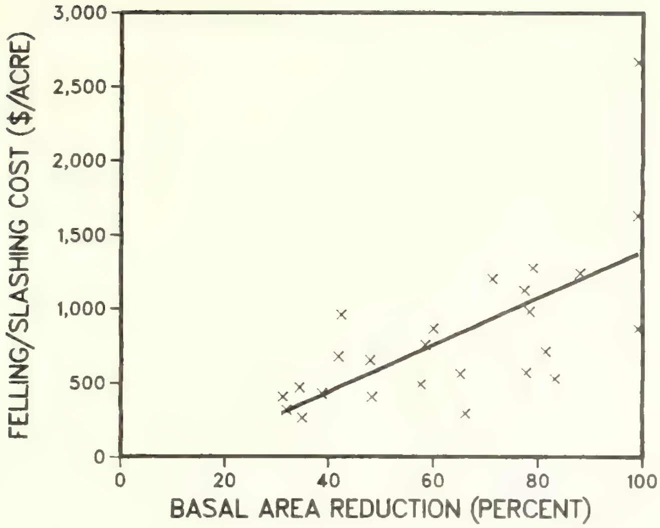

Figure 5--Felling and slashing cost per acre as a function of basal area reduction. Cost of treatment tends to increase with increases in basal area reduction. Cost is represented by the equation y = -189.84 + 15.81x (R^2 = 0.45, SEE = 397.98).

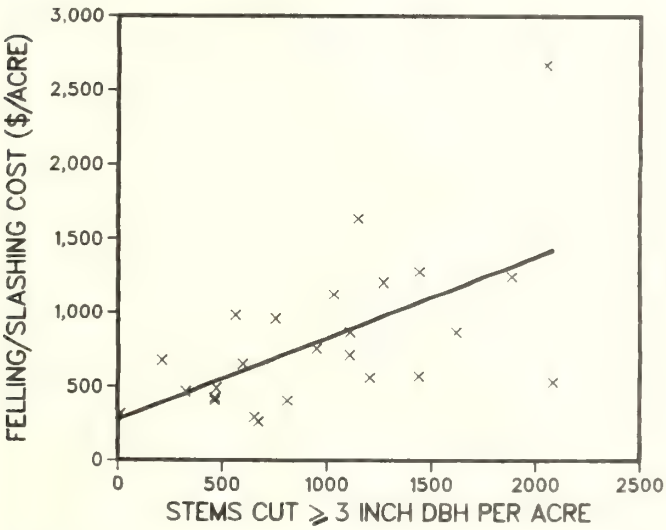

Figure 6--Felling and slashing cost per acre as a function of stems 3.0 inches and larger designated for cutting. Cost of treatment tends to increase with increases in the number of stems 3.0 inches and larger designated for cutting. Cost is represented by the equation y = 279.21 + 0.55x (R^2 = 0.35, SEE = 433.28).

The amount of effort devoted to optional product salvage obviously exerted a potent influence on treatment costs. This was quite apparent from our field observations and subjective analysis of production data. In our multiple regression analysis this variable also proved to be significant, based upon an index that reflected the level of effort devoted to product recovery.

In addition to the problem of myriad variables and limited observations, statistical analysis is further confounded by extreme operational disparities among contractors. Such inconsistencies tend to mask the effect of individual variables.

PRODUCT RECOVERY OPPORTUNITY

The primary products recovered were fenceposts, corral poles, and tree props. Other roundwood products recovered in minor amounts included panel poles, fence braces, barn poles, sawlogs, houselogs, lath logs, and firewood. Figure 7 pictures typical tree-length material decked at the unit boundary for conversion to post and pole products.

Figure 7--Typical tree-length material decked at the unit boundary for conversion to post and pole products.

The extent of salvage and selection of alternative products was obviously a function of tree size, form, and quality, as well as markets and prices. But salvage was also influenced by the vagaries of operator inclination. To some extent, the service contract payments and voluntary salvage option tended to inhibit product recovery, rather than encourage it as originally anticipated.

Our field observations and analysis of production data indicated that the extent of salvage and degree of product manufacture had a pronounced effect on total treatment cost. Operators seemed aware of their diminishing rate of return from intensified salvage.

Actual Product Volume and Value

Recovered products were valued f.o.b. manufacturing points at time of delivery. Piece counts and prices were based on a combination of operator reporting and field verification.

To generate cubic foot volumes and values, average volume per piece was calculated for each product classification. Average piece sizes were based on random samples of products in the field or on estimates of nominal piece size when sufficient samples were not available. Tables 9, 10, 11, and 12 show the sizes, volumes, and delivered values of the products salvaged from the study units.

Table 9--Product classification sample: Rattling Gulch, Corduroy East, Corduroy West, Corduroy North, Echo Lake (1983)[1]

Product	Length	Small-end diameter range	Average diameter Small-end	Average diameter Large-end	Volume Per piece	Value f.o.b. mill Per piece	Value f.o.b. mill Per ft^3	Sample size
	Feet	Inches	Inches	Inches	Ft^3	Dollars	Dollars	Pieces
Post	6.5	3.5-5.0	4.1	4.6	0.67	0.52	0.78	45
Post	8.0	5.0-6.0	5.7	6.2	1.55	.80	.52	10
Prop	8.0	1.5-3.8	2.4	2.9	.31	.32	1.03	18
Prop	10.0	1.5-3.8	2.6	3.2	.46	.40	.87	21
Pole	13.0	2.5-3.5	2.8	3.7	.76	1.07	1.41	24
Pole	17.0	1.8-2.5	2.0	3.0	.60	.70	1.17	0
Pole	17.0	2.5-3.5	3.0	3.9	1.12	1.36	1.21	27
Pole	17.0	3.5-4.5	4.0	5.0	1.90	1.75	.92	0
Pole	21.0	2.5-3.5	2.9	3.8	1.31	1.50	1.15	20
Pole	14.0	4.5-5.5	5.0	6.0	2.33	8.40	3.61	0
Pole	22.0	4.5-5.5	5.0	6.0	3.66	13.20	3.61	0
Houselog	12.0	5.0-6.0	5.5	6.5	2.37	7.20	3.04	0
Total								165

[1]Product size classifications and values were provided by operators. Averages were based on a random sample of products in the field (or estimated when not available). Volume was computed from Smalian's formula: V = ((b + t)/2) X L.

Table 10--Product classification sample: Currie Coulee North, Dry Fork East, Dry Fork West, Wet Park (1983)[1]

Product	Length	Small-end diameter range	Average diameter Small-end	Average diameter Large-end	Volume Per piece	Value f.o.b. mill Per piece	Value f.o.b. mill Per ft^3	Sample size
	Feet	Inches	Inches	Inches	Ft^3	Dollars	Dollars	Pieces
Post	6.5	1.5-2.5	1.8	2.2	0.14	0.00	0.00	5
Post	6.5	3.5-4.5	3.9	4.9	.69	.52	.75	5
Pole	17.0	1.5-2.5	1.9	2.9	.56	.00	0.00	10
Pole	17.0	2.5-3.5	3.0	4.0	1.16	1.25	1.08	0
Lath log	8.5	4.0-5.0	4.6	5.2	1.12	.75	.67	14
Total								34

[1]Product size classifications and values were provided by operators. Averages were based on a random sample of products in the field (or estimated when not available). Volume was computed from Smalian's formula: V = ((b + t)/2) X L.

Table 11--Product classification sample: Ballard Hill North (1983)[1]

Product	Length	Small-end diameter range	Average diameter Small-end	Average diameter Large-end	Volume Per piece	Value f.o.b. mill Per piece	Value f.o.b. mill Per ft^3
	Feet	Inches	Inches	Inches	Ft^3	Dollars	Dollars
Tree length	34.0	1.5-2.5	2.0	4.0	1.85	1.25	0.68
Sawlog	25.0	5.5-6.5	6.0	7.6	6.39	4.95	.77

[1]Product size classifications and values were provided by operators. Averages were based on a random sample of products in the field (or estimated when not available). Volume was computed from Smalian's formula: V = ((b + t)/2) X L.

Table 12--Product classification sample: South Flat (1983)[1]

Product	Length	Small-end diameter range	Average diameter Small-end	Average diameter Large-end	Volume Per piece	Value f.o.b. mill Per piece	Value f.o.b. mill Per ft³
	Feet	Inches			Ft³	Dollars	
Post	5.5	3.5-6.5	5.0	5.3	0.80	0.43	0.54
Prop	10.0	2.2-3.8	3.0	3.6	0.60	0.50	.83
Pole	12.5	4.0-5.0	4.5	5.3	1.65	0.70	.42
Pole	16.5	3.0-4.0	3.5	4.5	1.46	1.21	.83
Pole	20.5	3.0-4.0	3.5	4.8	1.97	1.40	.71
Houselog	16.5	5.5-	6.0	7.0	3.86	3.30	.85
Firewood	16.5	5.5-	6.0	7.0	3.86	2.14	.55

[1]Product size classifications and values were provided by operators. Averages were based on a random sample of products in the field (or estimated when not available). Volume was computed from Smalian's formula: $V = ((b + t)/2) X L$.

Total product value for each treatment subunit was aggregated by combining all reported piece counts and values for all product classifications. The total delivered value was then reduced to deck (roadside or landing) value by deducting a consistent loading and hauling allowance of $0.15 per cubic foot. This allowance represents the approximate average Northern Region cost for sawlog operations. It is applied here only as a consistent standard for deck valuation and is not represented as indicating actual cost.

Table 13 summarizes recovery by consolidated product categories and shows the total deck value for each subunit. For all 25 subunits, the weighted average deck value of products salvaged is $0.70 per cubic foot. Subunit averages range from $0.52 to $1.38 per cubic foot.

Product Potential

Although actual recovery is certainly of interest, it conveys only spurious evidence of the stand's true product potential. What the forest manager needs to know is how much product value is potentially available to offset the cost of stand treatment.

To evaluate the product potential of the 25 subunits, we used a methodology that we recently developed in a concurrent study (Hawkins and Schlieter, this proceedings). Each subunit was evaluated to see how much product value could have been generated from the stems actually cut and removed. This stepwise procedure predicted the maximum gross value alternative from all possible combinations of seven specified post and pole products. Gross stand values were reduced to net stand values by applying defect factors. These factors were derived from measured value reductions on five sample stands in our product prediction study--stands which happened to be control areas for five of the units in this study.

Basal area reduction and number of stems 3.0 inches and larger cut and removed had a pronounced effect on predicted product value. These relationships can be seen in tables 14 and 15.

RELATIVE FEASIBILITY OF TREATING STANDS

A prudent forest manager will want to identify those stands and treatments where desired biological responses can be achieved at the least net cost. An analysis of incremental costs and potential product value is useful for estimating probable net costs of (or returns from) stand treatments. In this approach, the cost of felling and slashing is the increment required to achieve the desired treatment. All or some part of this cost increment might be offset by product value. But first the product value must fully absorb an associated cost increment--the cost of product removal.

In some stands, the additional value gained from product recovery may enable the forest manager to increase basal area reduction without any appreciable increase in net treatment cost.

Our analysis shows such incremental costs (table 7), product recovery (table 13), and product potential (table 14) for each subunit. But because the removal costs in our study are grossly exaggerated by silvicultural research requirements (and are not related in any way to predicted product potential), we are not able to present meaningful results in terms of net treatment cost or return. We leave to the practitioner the task of estimating product removal costs founded on more realistic harvesting constraints, along with the final assessment of net results.

We were able to compare costs and opportunities in a general way. Table 14 provides an idea of felling and slashing costs in relation to significant variables and product recovery opportunities. Treatment costs are listed in ascending order.

Table 13--Summary of products recovered under contractor's salvage option (on a per-acre basis)[1]

Treatment unit and subunit		Products recovered				Total pieces	Volume and Value[2]	
		Posts	Props	Poles	Other		Cubic feet	Dollars
Rattling Gu	T-1	668	0	0	0	668	476	285
Rattling Gu	T-2	580	0	0	0	580	437	251
Corduroy E	T-1	161	167	484	0	812	666	609
Corduroy E	T-2	0	223	255	0	478	493	419
Corduroy E	T-3	1,134	125	172	79	1,510	1,332	1,440
Corduroy W	T-1	0	344	26	0	369	182	142
Corduroy W	T-2	452	126	144	0	721	562	392
Corduroy N	T-1	Stand did not contain any merchantable products						
Corduroy N	T-2	0	218	31	0	249	137	111
Echo Lake	T-1	87	0	329	0	416	426	428
Echo Lake	T-2	130	1,875	412	0	2,417	854	1,175
Currie N	T-1	Contractor elected not to salvage any products						
Currie N	T-2	Contractor elected not to salvage any products						
Dry Fork E	T-1	Contractor elected not to salvage any products						
Dry Fork E	T-2	0	0	93	0	93	107	100
Dry Fork W	T-1	Contractor elected not to salvage any products						
Dry Fork W	T-2	17	0	311	0	328	372	341
Wet Park	T-1	0	0	33	79	112	127	81
Wet Park	T-2	0	0	72	362	435	490	288
Wet Park	T-3	0	0	152	566	717	809	493
Ballard N	T-1	0	0	584	0	584	1,079	567
Ballard N	T-2	0	0	1,328	232	1,560	3,941	2,220
South Flat	T-1	0	0	696	11	707	1,155	729
South Flat	T-2	0	37	1,117	13	1,167	1,853	1,175
South Flat	T-3	202	188	1,565	47	2,002	2,907	1,694

[1]Products shown are a consolidation of contractor's actual salvage; volumes and values are not indicative of total stand product potential.

[2]Deck value (value f.o.b. plant less average load and haul cost of $0.15 per cubic foot), 1983 prices.

Table 14--Treatment costs and salvage opportunities for subunits, presented in ascending order of felling and slashing cost (on a per-acre basis)

Treatment unit and subunit		Basal area reduction	Stems <3 inches cut and removed	Cost to fell and slash	Predicted product value[1]
		Percent	No.	Dollars	
Corduroy Cr E	T-1	35	676	266	467
Corduroy Cr N	T-2	66	656	296	307
Corduroy Cr N	T-1	32	0	317	0
Ballard Hill N	T-1	31	815	409	816
Rattling Gu	T-2	48	468	409	562
Rattling Gu	T-1	39	468	429	506
Corduroy Cr W	T-1	34	328	470	181
Dry Fork E	T-1	57	475	491	196
Ballard Hill N	T-2	83	2,085	531	3,279
Corduroy Cr E	T-2	65	1,208	562	1,264
Wet Park	T-1	78	1,441	572	1,090
Currie Coulee N	T-1	48	600	653	459
Dry Fork W	T-1	42	212	677	89
Currie Coulee N	T-2	81	1,110	714	820
Echo Lake	T-1	58	951	756	760
Corduroy Cr E	T-3	100	1,620	869	2,140
Corduroy Cr W	T-2	60	1,112	869	966
South Flat	T-1	42	757	959	395
Dry Fork W	T-2	78	566	982	228
Dry Fork E	T-2	77	1,034	1,125	473
South Flat	T-2	71	1,271	1,204	915
Wet Park	T-2	88	1,887	1,243	1,936
Echo Lake	T-2	79	1,443	1,278	1,149
South Flat	T-3	100	1,125	1,635	894
Wet Park	T-3	100	1,925	2,670	1,871

[1] 1984 value f.o.b. manufacturing plant, based on Hawkins and Schlieter, this proceedings.

Percentage of basal area reduction and number of stems 3.0 inches and larger cut and removed are also shown to give an idea of the relative effects of these variables on cutting costs. Predicted product value is included to illustrate the level of salvage opportunity available. Table 15 shows the same information grouped by target basal area reduction subunits (33 percent, 66 percent, and clearcut).

The relative feasibility of treating stands seems to depend a great deal on product potential and market demand. Our results suggest that stands with larger proportions of trees over 3.0 inches, while having higher total treatment costs, often would show more favorable net results than stands composed of smaller trees. This is obviously because such stands tend to yield more product value with which to cover or offset treatment costs.

Thus, when there is a strong local market demand for recoverable products, the feasibility of treating stands appears to increase relative to increases in the number and average size of stems larger than 3.0 inches (relative to predicted product potential). In the absence of strong market demand, the cost-effective treatments seem to be in stands composed of smaller trees. Simply stated, as trees get bigger the cutting cost goes up, but so does the product value.

SUBJECTIVE ANALYSIS

Our frequent monitoring of work in progress during this study enables us to explain some of the study results with a reasonable degree of confidence.

Operator Efficiency

It was apparent that the contractor's experience, skill, organization, and motivation had more bearing on productivity and cost than did the harvesting system and equipment used. For example, contractors for the Corduroy and Rattling Gulch units were more productive using efficient hand-labor systems than were those on Wet Park and South Flat using a crawler tractor and wheel skidder operated by less organized crews. Use of the tree shear was especially detrimental to cutting cost in the Wet Park clearcut.

Salvage Intensity

The intensity of product salvage and extent of manufacture have a direct effect on both cutting and removal costs. This was evidenced by relatively high costs at Echo Lake T-2, Corduroy Creek East T-3, and South Flat T-1, 2, and 3, where utilization efforts were quite intensive. But at Ballard Hill North T-2, where salvage value was highest of all, costs were actually less; this was because nearly all material was marketed at the landing in tree-length decks, thus saving the costs of measuring, limbing, bucking, sorting, and piling products. Lower costs were also experienced at Currie Coulee North, Dry Fork East T-1, and Dry Fork West T-1, where no salvage attempt was made. The lowest of all total costs was at Corduroy North T-1, where the trees were so small that there was neither a salvage effort nor any requirement to remove material from the unit.

Basal Area Reduction

The amount of basal area removed obviously influenced the cost of felling and slashing, as well as the cost of removing cut trees 3.0 inches and larger. This observation was corroborated by both multiple- and simple-regression analyses. Basal area reduction also appeared to correlate well with predicted product value, although this premise was not tested statistically.

Depending on preharvest stand density and d.b.h., the basal area reduction targets resulted in a wide range of residual stem spacings. On the partial-cut subunits, these ranged from 4.0 feet for Corduroy North T-1 to 17.5 feet for Rattling Gulch T-2.

Residual stem spacing appeared to have a dichotomous effect on cost. While closer spacings obviously resulted in fewer trees to cut (and remove where required), they simultaneously had a deleterious effect on production and cost. This was because of a more constant concern for leave-tree selection and protection. The contractor at Currie Coulee North, Wet Park, and the Dry Fork units attempted (without proven success) to address this problem in part by premarking the leave trees.

Close residual spacings affected operators, especially when they were using cable winching systems for required removal. Residual spacings ranging from 5.5 to 6.5 feet at T-1 units such as Dry Fork East and West, Currie Coulee North, South Flat, and Ballard Hill North so inhibited production that the contractors eventually abandoned cable winching in favor of hand-dragging to the unit boundaries for subsequent piling or machine forwarding.

In this study, product-length hand-labor systems seemed to be the more productive alternative for treatments with closely spaced residual stands.

Stand Density and Tree Size

We believed that dense stands of small trees would be more costly to treat than more open stands of larger trees. Subjective analysis could not confirm this any more than did the statistical analyses.

We observed that cutting and slashing trees smaller than 3.0 inches accounted for far less of the total cutting cost than treatment of trees 3.0 inches and larger. This can be explained in part by the highly productive nature of "mowing down" dense stands of small trees with a chainsaw, unimpeded by concerns such as leave-tree selection, directional felling, product salvage, and stem removal. In this study, the cost of

Table 15--Treatment costs and salvage opportunities, grouped by treatment specification (on a per-acre basis)

Treatment unit and subunit	Basal area reduction	Stems <3 inches cut and removed	Cost to fell and slash	Predicted product value[1]
	Percent	No.	- - - - - Dollars	- - - -
T-1 Subunits 33 Percent Target Basal Area Reduction				
Corduroy Cr East	35	676	266	467
Corduroy Cr North	32	0	317	0
Ballard Hill North	31	815	409	816
Rattling Gulch	39	468	429	506
Corduroy Cr West	34	328	470	181
Dry Fork East	57	475	491	196
Wet Park	78	1,441	572	1,090
Currie Coulee North	48	600	653	459
Dry Fork West	42	212	677	89
Echo Lake	58	951	756	760
South Flat	42	757	959	395
T-2 Subunits 66 Percent Target Basal Area Reduction				
Corduroy Cr North	66	656	296	307
Rattling Gulch	48	468	409	562
Ballard Hill North	83	2,085	531	3,279
Corduroy Cr East	65	1,208	562	1,264
Currie Coulee North	81	1,110	714	820
Corduroy Cr West	60	1,112	869	966
Dry Fork West	78	566	982	228
Dry Fork East	77	1,034	1,125	473
South Flat	71	1,271	1,204	915
Wet Park	88	1,887	1,243	1,936
Echo Lake	79	1,443	1,278	1,149
T-3 Subunits Clearcut				
Corduroy Cr East	100	1,620	869	2,140
South Flat	100	1,125	1,635	894
Wet Park	100	1,925	2,670	1,871

[1]1984 value f.o.b. manufacturing plant, based on Hawkins and Schlieter, this proceedings.

cutting 3.0-inch and larger trees included the efforts of optional product manufacture as well as concerns for subsequent required removal. These factors contributed to increased cost.

Thus, once again the evidence seemed to confirm that the number of cut trees 3.0 inches and larger was a more valid indicator of treatment cost than was preharvest density, total stems cut, or average d.b.h.--at least when product recovery was anticipated. For example, Corduroy North T-2 had a preharvest density of 9,400 stems per acre. Average d.b.h. was 2.0 inches with 72 percent of the stems in the 1- and 2-inch classes. Sharply decreasing numbers of stems were in the 3- to 6-inch d.b.h. classes. Basal area was reduced 66 percent and a total of 8,214 stems per acre were cut. But only 656 of the trees cut per acre were 3.0 inches or larger. Felling and slashing cost in this unit was $296 per acre, next to the lowest of all 25 subunits in the study.

Compare this to data for Corduroy East T-1, which had a preharvest density of only 2,875 stems per acre. D.b.h. was considerably larger, averaging 3.7 inches with some stems as large as 8 inches. Basal area was reduced only 35 percent and a total of only 1,784 stems per acre were cut. But the number of cut trees 3.0 inches and larger (676 per acre) and the felling and slashing cost ($266 per acre) were both roughly comparable to Corduroy North T-2 costs.

This contention is further supported by data for Corduroy North T-1, a high-density stand with no trees larger than 3.0 inches. This was among the least costly stands treated.

At first glance, Echo Lake data apparently defy our theory. However, the higher cutting cost in this dense stand of small trees was clearly attributable to intensive manufacture of salvaged products as well as an extraordinary quality of workmanship. Ballard Hill North, with a large number of stems over 3.0 inches and relatively low costs, also seems to defy our logic. But low costs were achieved largely by lack of product manufacture (as noted previously) and by sacrificing job quality.

At the opposite end of this spectrum is Rattling Gulch, an open stand approaching a 5.0-inch average d.b.h. with very few small trees and only 468 cut trees per acre which were 3.0 inches or larger. A few trees were as large as 10 inches d.b.h. Cutting costs again ranked among the lowest. This was mainly because so few trees were cut. Lack of product salvage also improved the cutting cost position by avoiding much of the product manufacturing expense. Salvage was discouraged by large tree size, poor form, and a profusion of limbs, forks, and crooks.

To reiterate our impressions, as cutting costs escalate they tend to trend with the number of stems 3.0 inches and larger and not with total preharvest stems, total stems cut, or average d.b.h. Cases which do not follow this trend can be readily explained by operational inconsistencies such as gross inefficiency, intensity of optional salvage, and quality of workmanship.

Most Cost-Effective Operations

Originally, we anticipated a presentation of operator profit and loss. We planned to show the total costs of cutting and removal, actual product recovery value, and resulting profit or loss for each subunit. In such analysis, subunits showing a profit would indicate stand types, treatments, and harvesting systems where management priorities should be focused. Subunits with slight losses would suggest treatments that might be made for small investments. Large losses would denote submarginal stands, impractical treatments, or unfeasible harvesting systems.

This presentation was not made for two reasons: (1) research requirements that distorted removal cost and (2) inconsistencies of optional salvage efforts. However, the relative profit and loss results (not displayed here) confirmed some of our general impressions. Following are some observations about two of the most cost-effective operations in this study.

Ballard Hill North T-2--This was the most profitable of all operations among the 25 subunits. It had by far the best timber stand in the study.

Tables 1 and 2 show that this 80-year-old stand was growing on an excellent site (index 94), and had the greatest preharvest basal area (357 ft^2/acre). Harvesting removed the largest number of stems (2,085) and cubic feet (6,983) per acre. Trees here were among the largest (3.6-inch average d.b.h.), tallest (47 feet average total height), and best formed in the study. Felling and slashing cost was $531 per acre. More actual product value was recovered ($2,220) and more product was potentially available ($3,279) per acre than in any other subunit (tables 13 and 14).

A tree-length harvesting system was used. Trees were felled, hand-bunched with two or three butts placed in close proximity, winched to the unit boundary, and skidded about 500 feet to a landing. Although a few large trees were limbed and bucked into stud logs and sold on a delivered log basis, most of this material was sold at the landing in tree-length decks with limbs and tops attached. But it was not hauled in this form. The purchaser salvaged and manufactured products at the landing, absorbing the added cost of this work.

This subunit, however, was grossly overcut (83 percent basal area reduction), leave-tree selection was poor, leave-tree damage was excessive, and subsequent blowdown was severe. So some part of the profitability was certainly at the expense of quality.

In spite of the quality problems encountered on this subunit, the study results provide several clear indications regarding treatment opportunities: Highest priority should be given to the best sites. Stands that offer the best combination of density, size, form, and predicted product value should be selected for treatment. Tree-length logging and marketing are probably the most cost-effective combination.

Corduroy Creek East T-1--This was the second most profitable operation. The subunit timber also was among the better timber in the study.

This 85-year-old stand was moderately dense (2,875 stems per acre) and was composed of large (3.7-inch average d.b.h.), well-formed trees. Just 35 percent of the basal area was removed and target residual tree spacing was only 6.5 feet. The one-man hand-labor operation used here was extremely efficient and actual salvage was so intensive that the return substantially exceeded predicted product value. Felling and slashing cost was $266 per acre and predicted product value was $467 per acre.

Study results for this subunit suggest several conclusions: Again, the importance of site index, density, size, form, and predicted product value relative to basal area reduction is evident. These results also suggest that product-length hand-labor operations can be profitable when work is efficiently performed, salvage is intensive, and product marketing is astute.

Comparison of profitability between these two subunits tends to confirm our premise that the harvesting system is not nearly so important as is the operator's experience, organization, motivation, and marketing skill.

FURTHER RESEARCH OPPORTUNITIES

With this base of information to build upon, a series of followup studies could be conducted to experiment further with specified mechanical systems and operating techniques that might improve harvesting productivity. Such studies should be designed to provide a more realistic assessment of incremental costs by conforming more closely to customary product and service contract situations, rather than being bound by silvicultural research constraints. Analysis of comparative costs could be enhanced by requiring more uniform treatment of simulated merchantable material.

OUTLOOK FOR THE FUTURE

The results of this study indicate that salvage of salable products can often be used to offset some of the cost of desired silvicultural treatments in small-stem lodgepole pine. But recovery of products such as posts and poles is seldom great enough to cover all operational costs. Forest managers who prescribe intensive treatments will generally have to subsidize the operator to some extent, depending upon the stand's product potential. To minimize the amount of such subsidies, and to generate positive returns where possible, investments should be concentrated on the best sites and where combinations of tree density, size, and form culminate in the highest predictions of product value.

Low-capital, labor-intensive, family-type operators are the primary resource currently available for harvesting treatments. Limited and unstable markets for small-stem lodgepole pine, coupled with low and fluctuating values, combine to discourage the development of efficient, high-volume, mechanized contractors.

In this study, the better contractors excelled in areas such as crew organization, worker experience, individual motivation, equipment utilization, and marketing ability. These attributes appeared to affect productivity and recovery more than the harvesting system and equipment used. There are opportunities for further cost reduction and revenue generation by refining these basic technical, management, and marketing skills. The most needed impetus can only come from development of stable, high-capacity commodities markets, along with better prices, for small-stem lodgepole pine.

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PRODUCTIVITY OF ALTERNATIVE HARVESTING SYSTEMS IN SMALL TIMBER

Henry L. Goetz

ABSTRACT: Presents productivity and cost data for the felling/bunching, skidding or yarding, and forwarding phases of full-tree harvesting operations on eight thinning and two clearcut units. Trees were felled manually and removed from the woods with grapple-equipped farm tractors, winches, or small skyline yarders. Total stump-to-landing costs ranged from \$0.16 to \$0.80/ft^3 depending on tree size, terrain, harvesting system, and silvicultural prescription.

INTRODUCTION

Full-tree thinning systems have been tested extensively in the Lubrecht Experimental Forest and on neighboring land in western Montana's Blackfoot River Valley since 1975. Full-tree thinning is the term used to describe a system in which trees are felled, piled into bunches, and with limbs and tops attached, removed to a central landing for processing or disposal. The cooperative experiments and demonstration cuttings have involved the Forest Service, U.S. Department of Agriculture (Intermountain Research Station, Northern Region, and Missoula Equipment Development Center), Champion Timberlands, Potter Logging, and the Montana Department of Natural Resources and Conservation. Bill Potter started the initial full-tree system in response to a mountain pine beetle infestation on his ranch. Development and application of the full-tree thinning system on gentle and steep terrain have been described previously (Goetz 1980, 1981, 1982, 1983a, 1983b; Goetz and Maus 1986; Host and Goetz 1983; Maus and Goetz 1986). Copies of the 1986 reports are available from the School of Forestry at the University of Montana in Missoula.

These systems emphasized low-cost portable and versatile equipment that a rancher, woodlot owner, or small contractor could use to thin stands of small timber. The project had two purposes. The first was to demonstrate the many benefits of full-tree thinning, including reduced potential fire and insect damage, easier reentry for future harvests, increased browse for livestock and wildlife, better recreational opportunities, and enhanced esthetic qualities. The second purpose was to determine if some or all of the thinning costs could be offset by the sale of small stems that traditionally have not been marketable. The reports cited previously discuss the variety of markets for material recovered in full-tree thinnings.

This paper has two objectives: (1) to review the methods and machinery used in full-tree harvesting and (2), using data from 10 representative treatment units, to illustrate how terrain, machinery, crew size, and tree size affect productivity and costs. Although much of the work reported was in ponderosa pine, western larch, and Douglas-fir, this information should be generally applicable to stands of small lodgepole pine.

METHODS AND MACHINERY

A full-tree thinning operation consists of at least three and sometimes four phases: felling and bunching, skidding or yarding, forwarding to the landing (on steep terrain), and processing. Because the final products from the 10 treatment units varied significantly, processing productivity and costs could not be directly compared. Therefore, only the first three steps will be presented.

Felling and Bunching

On gentle terrain (slopes <20 percent), a three-person crew, consisting of a sawyer and two stackers, felled and bunched stems less than 5 inches diameter at breast height (d.b.h.). The crews cut the trees as close to the ground as possible. The number of stems per bunch varied with tree size, stand density, and type of skidding or yarding machine used. Although crews can fell and bunch stems larger than 5 inches d.b.h., a small mechanized feller-buncher is two to three times faster than manual methods.

A two-person crew was more efficient than three people on steeper terrain. When thinning smaller trees, the crew piled the trees with butts facing the yarding corridor. The crew did not attempt to pile the larger trees and instead directionally felled them downhill in a herringbone pattern.

Felling and bunching is the most critical phase of the system on both gentle and steep terrain because it dictates the flow in the remaining steps. Poor placement or improper bunch size adversely affects skidding and yarding production.

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Henry L. Goetz is the manager of the Lubrecht Experimental Forest, School of Forestry, University of Montana.

Skidding and Yarding

A conventional farm tractor, protected with extra guarding and equipped with a shop-built grapple, was the primary skidding machine used on gentle terrain. Potter designed and built the first versions of the grapple. Plans and specifications for the current model are available from the Equipment Development Center, Forest Service, Missoula, MT. A John Deere Model 440 or 540 grapple skidder was used for larger trees, longer distances, or rougher terrain. In one series of tests, we used the Kolpe Radio-Tir skidding winch to bunch stems for forwarding to the landing with the farm tractor.

On steep terrain, we tested four different yarding machines--two winches and two skyline yarders. The first winch was the Kolpe Radio-Tir. The major advantages of this 330-lb unit were: (1) the radio control feature enabled the operator to control winching from the woods, and (2) the drive rollers of the winch rotated backward while idling and fed the cable out at the rate of a normal walk. The major disadvantage of the unit was the low maximum line pull (1,700 lb) generated by the 6-hp engine. To overcome this lack of power, we also tested a tractor-mounted winch to yard bunches of small trees on short, steep pitches less than 200 ft long. Such winches are available in a range of sizes that fit tractors with 20 hp or more. They are all driven by the power-take-off shaft of the tractor and carry a variety of cable sizes, depending on the specific model. Although many units do not have some of the desirable features of the radio-controlled winches, they do have sufficient pull to yard larger bunches or even sawlogs. For people with tractors, these winches are much less expensive (costs range from $1,200 to $3,000) than the radio-controlled models.

Normally, a three-person crew was used with the winching systems. One person operated the winch and the other two pulled line, carried skidding pans and nose cones, set chokers, and placed breakaway blocks.

The Missoula Equipment Development Center designed both yarders used in the tests. Each was rigged in a live skyline configuration. The Bitterroot Miniyarder is powered by an 18-hp gasoline engine that develops a maximum line pull of 2,000 lb through a hydrostatic transmission. It has a 17-ft tubular steel A-frame boom and a hydrostatic transmission and can be mounted on either a 3/4-ton truck or small trailer. We used the trailer-mounted version exclusively because of its mobility and ease of setup on ridgetops and narrow roads. Parts and rigging for the machine, including a Christy carriage, cost about $7,500. The skyline drum carries 600 ft of 3/8-inch cable, and the mainline drum has 800 ft of 1/4-inch line.

A three-person crew was used in thinning operations. One person operated the yarder and unhooked incoming turns at the landing. The two people in the woods set chokers, moved the skyline stop, and placed breakaway blocks. For clearcuts, we used only one person in the woods.

We also tested the larger and more expensive Clearwater Yarder in a lodgepole pine thinning and a clearcut to compare production rates with the Bitterroot. This three-drum machine has a 97-hp diesel engine that powers a hydrostatic transmission. The skyline drum holds 800 ft of 1/2-inch line, and the mainline drum has a capacity of 900 ft of 3/8-inch cable with a maximum line pull of 3,500 lb. Line speeds vary from 0 to 1,000 ft/min. The yarding crew consisted of one operator/chaser and two people in the woods for both thinnings and clearcuts.

We used a variety of accessory equipment with the different machines to increase efficiency and production. The most helpful item was the breakaway block, which consists of a sheave block with a spring-loaded keeper over the pulley. The block is equipped with a nylon strap that can be wrapped around a tree for easy placement. When the butt rigging on the line trips the keeper, the line derails from the block, and the turn automatically changes direction. We used this device at the junction of the main and lateral yarding corridors during thinning to minimize damage to the residual trees. Breakaway blocks were also used with nose cones and skidding pans on the Kolpe winch units to prevent hangups. We attached a tieback cable to the carriage stop on the skyline of the yarders. This line stabilized the carriage during lateral yarding and reduced damage to trees adjacent to the main corridor. To overcome profile problems in some of the corridors, we tested the intermediate support model of the Christy carriage. It worked well with both yarders.

Forwarding

On gentle terrain, the tractor moved the bunches directly from the woods to the landing. In some instances, the trees were processed immediately--often full-tree chipped for boiler fuel. In other cases, they were shingle stacked for future processing. Shingle stacking is a cold-decking method in which the drag is heeled with the tops off the ground at a 20- to 30-degree angle and backed into a stack. Succeeding bunches then overlap the previous material, and only the butts of the trees are in contact with the ground. Using this system, the same machine can skid, deck, and feed the chipper (Goetz 1982).

The farm tractor was also the main forwarding unit for the winch systems and the Miniyarder. The Kolpe bunched piles along the main skidway for the tractor. With trees 5 inches d.b.h. and smaller, three winch piles were equivalent to one turn for the tractor. When using the tractor winch, the crew would first yard a series of bunches to the road or skidway. They would then replace the winch with the grapple (a 15-minute operation), and one person would forward while the other two crew members thinned another strip. The farm tractor was ideally suited to move material from the Miniyarder to the landing

Table 1--Unit descriptions

Unit	Species	Terrain	Average stem size	Stems removed per acre	Type of treatment
			Ft^3		
1	Western larch	Gentle	0.8	2,500	Thinning
2	Ponderosa pine	Gentle	1.4	1,888	Thinning
3	Lodgepole pine	Gentle	3.0	1,160	Thinning
4	Ponderosa pine	Gentle	1.2	994	Thinning
- - - [1]					
5	Douglas-fir	Steep	.7	1,331	Thinning
6	Ponderosa pine	Steep	1.4	866	Thinning
7	Western larch	Steep	.9	1,038	Thinning
8	Lodgepole pine	Steep	8.0	665	Thinning
9	Lodgepole pine	Steep	7.6	626	Clearcut
10	Lodgepole pine	Steep	8.3	659	Clearcut

[1]The dashed line is used in all tables to differentiate between gentle and steep terrain.

because the capacities of the two machines match closely. In addition, the tractor moved the trailer-mounted yarder between settings. With the Clearwater, we used the larger capacity John Deere 440 grapple skidder as the forwarder.

PRODUCTIVITY

Productivity and cost data are based on 10 representative units with different combinations of logging systems, stand conditions, and tree sizes. The units are described briefly in table 1; average stem sizes in cubic feet are for those trees removed from the stand. Units on gentle terrain had slopes less than 20 percent; units on steep terrain had slopes ranging from 25 to 50 percent. The thinned stands had an average residual spacing of 14 by 14 ft or a stand density of about 220 trees per acre. Data from two small clearcuts are included for comparison.

Although stems per hour were used to measure productivity in the field, the data were also converted to cubic feet per crewmember working hour in the productivity tables. During working hours, the crew or machine was engaged in harvesting-related activity, including operational time, equipment downtime, and time spent in associated activity such as changing yarding corridors; this definition excludes unit layout, travel, lunch breaks, and record keeping.

Felling And Bunching

Table 2 summarizes felling and bunching productivity for the 10 units. Generally, cubic foot productivity per person per hour increased consistently as the average tree size increased. Felling and bunching productivity in all cases was lower for comparable tree sizes on steep terrain (units 5-7) because it was more difficult to bunch trees on steeper ground. In units 8-10, the two-person crew made no attempt to bunch the trees because of the steep slopes. However, productivity in cubic feet per person per hour increased dramatically when the average tree contained about 8 ft^3. In addition, as indicated by a comparison of unit 8 with units 9 and 10, treatment differences affected productivity--there was a significant productivity increase in the clearcuts compared to the thinnings. Crew experience and amount of downtime account, in part, for the differences in productivity on units 9 and 10.

Table 2--Felling and bunching production rates

Unit	Crew size	Average stem size	Stems per person per hour	Cubic feet per person per hour
		Ft^3		
1	3	0.8	56	45
2	3	1.4	45	63
3	2	3.0	26	78
4	3	1.2	48	58
- - -				
5	3	.7	41	29
6	2	1.4	22	31
7	2	.9	48	43
8	2	8.0	12	99
9	2	7.6	20	152
10	2	8.3	29	241

Skidding and Yarding

Table 3 lists the skidding/yarding production rates for the 10 units. Unit 2 was skidded by an inexperienced tractor operator during the winter, which may account for the lower-than-expected production rate (compared to unit 1). Generally, one tractor could always keep up with one thinning

Table 3--Skidding/yarding production rates

Unit	Skidder/yarder	Average distance	Average stem size	Stems per person per hour	Cubic feet per person per hour
		Feet	Ft^3		
1	Tractor	500	0.8	212	170
2	Tractor	500	1.4	118	165
3	Tractor	750	3.0	58	174
4	Kolpe winch	80	1.2	64	77
5	Kolpe winch	150	.7	36	25
6	Tractor winch	125	1.4	48	67
7	Miniyarder	275	.9	51	46
8	Miniyarder	275	8.0	10	78
9	Miniyarder	275	7.6	12	92
10	Clearwater	330	8.3	16	133

crew and, in many instances, it could skid for two crews. Lower productivity in the Kolpe winch plots was at least partially the result of a larger crew size. The impact of tree size is demonstrated by the higher productivity in unit 8 compared to unit 7. Productivity for unit 9 (clearcut) was somewhat higher than that for unit 8 because the two-person crew did not have to yard around residual trees; this difficulty was partially offset by using a three-person crew in unit 8. As expected, the best production rates on steep terrain were achieved with the larger Clearwater Yarder, even though the average yarding distance was longer.

The results for units 7-9 are similar to those from other Miniyarder studies. Lynch (1986) reported production rates of 54 ft^3 per crewmember-hour for a two-person crew salvaging material from a fire-killed stand of lodgepole pine in Colorado. The average piece size was 11.7 ft^3. In Appalachia, a four-person crew averaged 34 ft^3 per productive crewmember-hour yarding fuelwood, averaging 5 ft^3 per piece from a hardwood clearcut (Baumgras and Peters 1985). In Washington, a four-person crew used a Miniyarder to remove red alder from sites being converted to commercial timberland; at an average piece size of 5 ft^3, Brown and Bergvall (1983) expected to produce 50 ft^3 per crewmember-hour on an operational basis.

Forwarding

Table 4 lists forwarding production rates for units 4-10. For units 1-3, forwarding and skidding activity are combined in table 4 because the tractor skidded the bunches of trees directly from the woods to the landing. Grapple-equipped farm tractors forwarded trees on all plots except unit 10, where a John Deere 440 grapple skidder moved material from the Clearwater. In unit 9, the tractor operator also limbed and topped the trees before decking.

Table 4--Forwarding production rates

Unit	Average forwarding distance	Average stem size	Stems per person per hour	Cubic feet per person per hour
	Feet	Ft^3		
4	400	1.2	360	432
5	225	.7	371	260
6	550	1.4	125	175
7	325	.9	168	151
8	700	8.0	116	931
9	100	7.6	118	897
10	250	8.3	203	1,685

Combined Production Rates

In table 5, production rates for felling and bunching, skidding/yarding, and forwarding have been combined for the entire operation from stump to landing. The values for each unit represent the number of stems or cubic feet that were felled and bunched, skidded or yarded, and forwarded to the landing per person per working hour. Although no attempt was made to statistically identify causes of variation between units, some general observations from table 5 should be emphasized:

1. for units 1-3, volumetric production rates increased as the size of the average tree increased, and the productivity for unit 3 would have been substantially greater if the skidding distances had been similar for all units;

2. the volumetric production rate for unit 4 (Kolpe-bunched) was less than that for any of the tractor-skidded units;

Table 5--Combined production rates--stump to landing

Unit	Skidder/yarder	Average stem size	Stems per person per hour	Cubic feet per person per hour
		Ft^3		
1	Tractor	0.8	45	36
2	Tractor	1.4	33	46
3	Tractor	3.0	18	54
4	Kolpe winch	1.2	25	31
5	Kolpe winch	.7	17	12
6	Tractor winch	1.4	13	19
7	Miniyarder	.9	20	18
8	Miniyarder	8.0	6	46
9	Miniyarder	7.6	8	58
10	Clearwater	8.3	10	81

3. even though the forwarding distance in unit 6 was twice as long as in unit 5, the productivity of the tractor winch was greater than that of the Kolpe;

4. the difference in production rates between the plots thinned with the Miniyarder was primarily a result of differences in tree size;

5. the productivity differences between thinning units and clearcuts reflected the greater difficulty of yarding at thinned sites as well as the smaller yarding crew used in the clearcuts; and

6. the greater speed and power of the Clearwater are partly responsible for the high production rates for unit 10.

COSTS

The cost-per-cubic-foot calculations are based on the following hourly rates for labor and machinery:

Item	Rate per hour
	(Dollars)
Labor (base = \$6.00; payroll costs = \$2.00; overhead = \$.72)	8.72
Tractors and small skidders	12.00
Tractor winching only	6.00
Kolpe Radio-Tir winch	3.68
Bitterroot Miniyarder	7.00
Clearwater yarder	22.96
Chainsaws	1.50

The rates for labor, tractors/skidders, and chainsaws are consensus estimates by people closely associated with small-stem harvesting in the Northern Rocky Mountain region. We believe these figures accurately reflect rates currently being paid by post/pole operators, private nonindustrial landowners, and small contractors. The labor rate is constant because crewmembers typically rotate jobs frequently during an operation. Obviously, these rates would not apply to a highly capitalized, production-oriented, corporate woods operation. These costs reflect the fact that most landowners and small contractors operate their own equipment, perform higher-than-average preventive maintenance, do many of their own repairs, and depreciate the machinery over a long time period.

The rates for the Kolpe winch, Miniyarder, and Clearwater were calculated as indicated in the appendix. Because the Clearwater Yarder is not commercially available, the costs are based on a comparable machine--the trailer-mounted Christy Small Wood Yarder.

Table 6 summarizes the costs of felling and bunching, skidding/yarding, and forwarding for the 10 units. The total costs are for those three phases only and, with the exception of unit 9, do not include limbing, bucking, and processing at the landing. The costs reflect working hours as defined previously; they do not include operating overhead or a margin for profit and risk.

Data in table 6 demonstrate the effect of harvesting system, tree size, terrain, and silvicultural treatment on small-stem production costs. The costs range from a high of \$0.80/ft^3 for unit 5 where very small stems were bunched with the Kolpe, to a low of \$0.16 for the lodgepole pine clearcut yarded with the Clearwater. The average cost per cubic foot delivered to the landing for all 10 units was \$0.38. Hawkins (this proceedings) determined that the average value of processed lodgepole pine products at the landing

Table 6--Summary of costs per cubic foot for three production phases

Unit	Stem size in cubic feet	Costs per cubic foot: Felling and bunching	Skidding/ yarding	Forwarding	Total
		- - - Dollars - - -			
1	0.8	0.20	0.12	0	0.32
2	1.4	.15	.13	0	.28
3	3.0	.12	.12	0	.24
4	1.2	.16	.13	0.05	.34
5	.7	.32	.40	.08	.80
6	1.4	.30	.16	.11	.57
7	.9	.23	.24	.14	.61
8	8.0	.10	.15	.02	.27
9	7.6	.06	.13	.02	.21
10	8.3	.04	.11	.01	.16

was \$0.76/ft^3. Even if a generous amount is allowed for processing, operating overhead, and profit and risk, many of these systems should produce small lodgepole pine roundwood products at a profitable rate.

CONCLUSIONS

Based on the Lubrecht studies, a number of conclusions can be drawn about full-tree thinning systems, the machinery used, and expected production rates. The successful application of small-scale systems requires compromise and cooperation among the silviculturist, marking crew, and logger. For example, sale layout must consider the special requirements and limitations of the machinery involved--a form of corridor cutting may be most efficient in many cases. A closely coordinated approach is also necessary in the entire operation from stump to landing.

The various skidding and yarding machines all functioned well and had a minimum of downtime. It is important for the operators to fully understand the power limitations of the machinery and to develop operating techniques based on finesse rather than horsepower. The simple operation and easy maintenance of these small machines enhance their suitability for landowners and part-time contractors. The use of accessory equipment such as breakaway blocks, nose cones, skyline tiebacks, and intermediate supports is critical to efficient use of the cable yarding units.

Production rates will vary with size of timber, size of crew, terrain, silvicultural prescription, and type of machinery used. However, the most important factors are the determination, innovation, initiative, and flexibility of the crew. The potential profitability of any of these systems is limited by the crew as well as by the particular combination of machines used.

Production costs per cubic foot depend on tree size. In general, the larger the average stem, the lower the production costs. For similar-sized material on gentle terrain, direct skidding from the woods appears to be more efficient than prebunching with a winch. For the same size trees, production costs for winches and small yarders on steep terrain are about twice those of ground-skidding systems on gentle terrain. As expected, costs are higher for thinning units than for clearcuts.

Although current values for hogfuel, firewood, and pulpwood may not always be sufficient to pay the entire cost of a thinning operation for some species, many of these systems should be economically feasible for small lodgepole pine roundwood products.

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Appendix: Machinery Cost Estimates

Item	Machine[1]		
	Kolpe	Miniyarder	Christy
Assumptions:			
Initial cost, fully rigged	$8,000	$16,500	$69,500
Equipment life, years	5	5	8
Machine salvage value, percent	0	20	20
Depreciation, dollars per year	$1,600	$2,640	$7,400
Scheduled hours annually	1,200	1,200	1,200
Maintenance and repairs	50 percent of depreciation		
Taxes, insurance, and interest	20 percent of average annual investment		
Fixed costs--dollars per scheduled hour			
Depreciation	$ 1.33	$ 2.20	$ 6.17
Taxes, insurance, and interest	.80	1.87	8.02
Total fixed costs	$ 2.13	$ 4.07	$ 14.19
Operating costs--dollars per scheduled hour			
Maintenance and repairs	$ 0.67	$ 1.10	$ 3.08
Fuel	.19	.50	1.83
Oil, filters, lube	.03	.10	.37
Wire rope--two sets per year for Kolpe and Miniyarder, one for Christy	.24	.61	2.87
Miscellaneous	.42	.62	.62
Total operating costs	$ 1.55	$ 2.93	$ 8.77
Total costs	$ 3.68	$ 7.00	$22.96

[1] The initial cost of the Christy yarder includes a talkie-tooter type communication system. Inexpensive, voice-actuated, FM radios are included in the miscellaneous category for the Miniyarder.

MECHANIZED SYSTEMS FOR HARVESTING SMALL-STEM LODGEPOLE PINE IN MOUNTAINOUS TERRAIN

Michael J. Gonsior and John M. Mandzak

ABSTRACT: A study employing a Timbco feller-buncher showed that the advantages of mechanization could be readily extended into steep terrain that adjoins gentle terrain or is otherwise replete with large landings. However, much mountainous terrain, characterized by narrow, tortuous roads incised in steep slopes, presents obstacles to complete ground-based mechanization that are yet to be overcome. The Timbco's performance seemed to be affected more by stand density and utilization specifications than by topography.

INTRODUCTION AND PURPOSE

Lodgepole pine has peculiarities that can significantly influence harvesting and utilization development options. Among the most obvious characteristics are its normally small diameter, intermediate branchiness, thin bark, and generally favorable wood quality and utility for studs, roundwood products, pulp chips, and composition board.

Lodgepole pine tends to have a wide habitat distribution. Much of its range is on flat-to-rolling, frost-pocket lowlands with few impediments to mechanized harvesting and transport. It also occurs quite extensively on high-elevation plateaus and steep slopes with limited or no road access. Thus, lodgepole stands occur in areas that may be restricted to snow-free harvesting seasons because of steep slopes and poor road access, as well as areas that can be harvested relatively easily all year.

The silvicultural potential of lodgepole pine depends substantially on harvesting and utilization options, both for existing stands and for development and management of productive replacement stands. In many areas of its range, lodgepole pine has potential for producing an acceptable and profitable timber crop. Natural regeneration is often easily obtained. Precommercial thinning is often required to avoid early stand stagnation and encourage production of stems sufficiently large to increase stand values and reduce harvesting costs. However, the generally modest annual stand volume increments dictate that investments be constrained at a low level.

Small lodgepole pine trees are somewhat unusual in that, depending on stand density and other factors, they may be of relatively high value for specialty products such as fenceposts, fence rails, and tree stakes. However, markets for such products are small in comparison with the available resource (Barger and Fiedler 1982); and for potentially large-volume markets (such as pulp, fiberboard, or energy production) small lodgepole has little or no advantage over other species. The harvesting cost per unit volume rises as tree size diminishes for lodgepole as for other species; and the large-volume markets generally can attract sufficient supplies of larger, lower cost material (Gonsior and Johnson 1985; Mandzak and others 1983).

Solutions to small-tree harvesting problems require a focus on relatively local conditions. An understanding is required not only of the nature of the available timber resource, but also of the local operating environment. Terrain, climate, the currently available harvesting equipment and how it may be employed, and the actual and potential markets for various products that might be produced must be evaluated.

There are two complementary methods for evaluating alternative solutions for a local harvesting problem. Equipment and technique demonstrations can be effective, particularly when harvesting and product requirements seem to be well understood. Data collection and modeling concurrent with harvesting trials also are useful for objective analysis, especially if the data can be used to evaluate a wider array of alternative harvesting schemes. For example, feller-buncher and skidding production data may be equally useful for evaluation of in-woods chipping and roundwood production schemes.

Mechanization has been an important factor in reducing the cost of harvesting small timber, thus enhancing opportunities for its utilization in high-volume markets (Gonsior and Johnson 1985). However, full mechanization may not be practical if capital is limited, if the markets

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Michael J. Gonsior is Research Engineer, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Bozeman, MT.; John M. Mandzak is Silviculturist, Champion International Corporation, Western Operation, Milltown, MT.

require small volumes, or if work is too sporadic to accommodate a capital-intensive approach.

Until recently, mechanized felling and bunching has been restricted to relatively gentle terrain due to equipment design limitations. However, recent innovations have extended feller-buncher capabilities to relatively steep slopes. One such innovation, the Timbco feller-buncher, was a key element in a study we conducted in a variety of stand and terrain situations in western Montana. Our study was designed to meet four objectives:

1. Evaluate the potential of ground-based, mechanized, multiproduct harvesting systems incorporating a Timbco feller-buncher for steep terrain.
2. Determine the safe operating limits of the Timbco regarding tree size, slope, and ground conditions.
3. Determine operating rates and productivity of production system components as functions of slope, tree size, and other variables.
4. Develop models to predict performance in situations other than those directly observed.

This paper presents and discusses some of our study results that pertain to small-stem lodgepole pine stands. In addition to information on the performance of the Timbco, results from associated studies of mechanized delimbing, debarking, and chipping operations are provided. The reader should find these results and associated discussions useful in deciding where such systems might be used, as well as for predicting performance and assessing financial feasibility.

TIMBCO PERFORMANCE

The Timbco is a tracked feller-buncher designed to operate in steep terrain. Its cab and boom mount can be leveled on slopes up to 27 degrees, or about 50 percent.

The Timbco in our study was monitored in 26 cutting units at five locations during the 6 months from August 1984 to February 1985. The Timbco operators tallied all trees cut, total operating time, and unscheduled downtime (UDT) due to equipment breakdowns or other causes, day by day and unit by unit. We employed observers to acquire detailed time and motion information.

Availability and Utility

The study period spanned 184 calendar days. The Timbco operated during at least part of 89 of these days, 5 of which were on weekends. Subtracting weekends and holidays, there were 122 scheduled workdays during the study, so the Timbco's gross availability was about 48 percent (89/184) based on total calendar days, or about 73 percent (89/122) based on scheduled workdays. Among the reasons for lost workdays were mechanical problems (for example, 2 days were lost due to engine failure requiring field overhaul, and a week was lost due to fuel pump failure) and weather (it was too dangerous for outdoor work due to stormy conditions, or the fuel became so viscous that the engine would not run).

For the 89 days during which the Timbco operated, operating periods ranged from 0.5 to 22.5 hours per workday, averaging about 8 hours. Operators recorded only about 50 hours as UDT, a little more than 7 percent of their total workday time. However, the time and motion studies--which accounted for about half the total hours recorded by the operators--showed that nearly 20 percent of the time was UDT, as shown in figure 1. Of course, it is possible that the operators and the time and motion study monitors disagreed regarding what was or was not UDT.

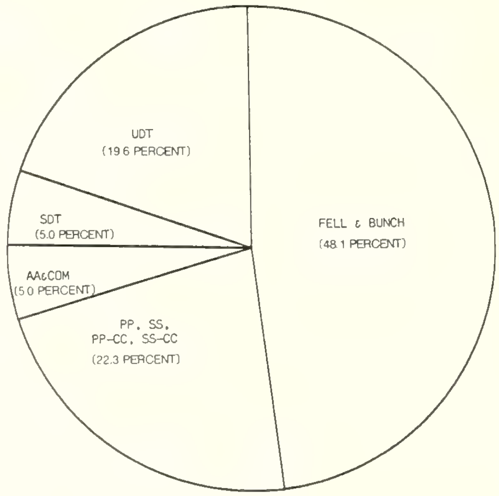

Figure 1--Timbco activity distribution (percent of observed time excluding lunch periods) for entire study. UDT=unscheduled downtime; SDT= scheduled downtime; AA=ancillary activities; COM=commuting; PP=position-to-position moves; SS=strip-to-strip moves; PP-CC=position-to-position moves, including cutting and carrying one or more trees during moving process; SS-CC=strip-to-strip moves, including cutting and carrying one or more trees during moving process; FELL & BUNCH=basic felling and bunching activity while carrier is stationary.

From the time and motion study data, we determined that 70.4 percent of the observed time was spent in the basic productive function: felling and bunching accounted for 48.1 percent of the observed time; moving from position to position (PP, PP-CC) or from strip to strip (SS, SS-CC) accounted for 22.3 percent (fig. 1). (CC means that one or more trees were cut and carried in the process of moving from position to position or from strip to strip.) The remaining 29.6 percent of observed time was recorded as UDT, scheduled downtime for maintenance, refueling, etc. (SDT), commuting between units or between landings and unit interiors (COM), and ancillary activities essential to the work but not directly productive (AA), such as maneuvering down timber or checking for unit boundaries.

Basic Productivity

Figure 2 shows the mean time per tree and number of observations vs. estimated diameter at breast height (d.b.h.) for felling and bunching one tree

at a time, without accumulating. These data represent all the one-tree cycles observed during the study, and they imply a gradual increase in time per tree with increasing d.b.h., up to about 14 inches, beyond which the time per tree increases rapidly with increasing d.b.h.

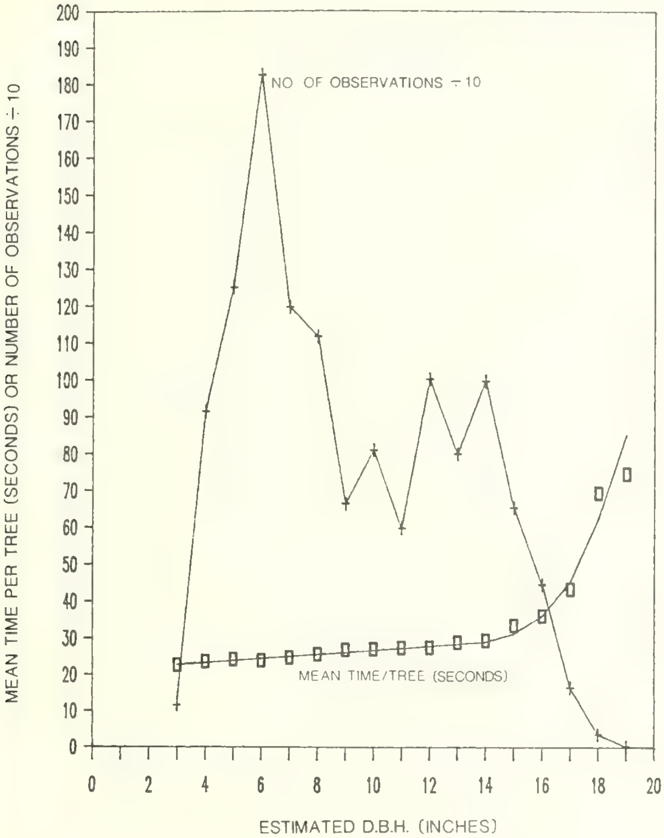

Figure 2--Mean time per tree and number of observations vs. d.b.h., Timbco system, one tree per cycle, for entire study.

To illustrate the effectiveness of accumulating trees before placing them on the ground, figure 3 shows the mean time per tree and number of two-tree cycles observed vs. the mean estimated d.b.h., along with the relationship for one-tree cycles inferred from figure 2. This implies a reduction in mean time per tree in the range of 25 to 30 percent from one-tree cycles (for trees between 3 and 10 inches d.b.h.) when two trees are cut and bunched per cycle. Figure 4 shows further time savings when three and four trees are cut and bunched per cycle. (The abscissas in figures 3 and 4 are actually the rounded means of estimated d.b.h. Usually the estimates of d.b.h. for the trees in multiple-tree cycles varied by no more than an inch or two; so this method of portrayal seems reasonable.)

Effects of Slope, Season, and Utilization

During the summer and early autumn study period, trees as small as 3 inches d.b.h. were utilized. Figure 5A shows the mean time per tree vs. d.b.h. for one-tree cycles, and figure 5B shows activity distributions (as bar charts) for three slope classes during this part of the study. Figure 5 implies decreasing Timbco availability with increasing slope; but no pronounced or consistent effect of slope on basic productivity (mean time per tree) is evident.

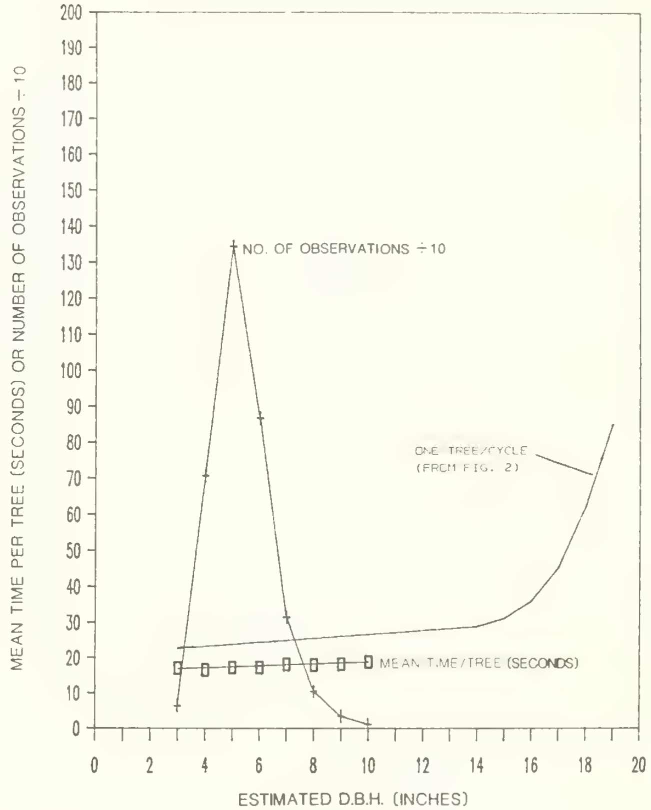

Figure 3--Mean time per tree and number of observations vs. d.b.h., Timbco system, two trees per cycle (compared with one-tree cycles) for entire study.

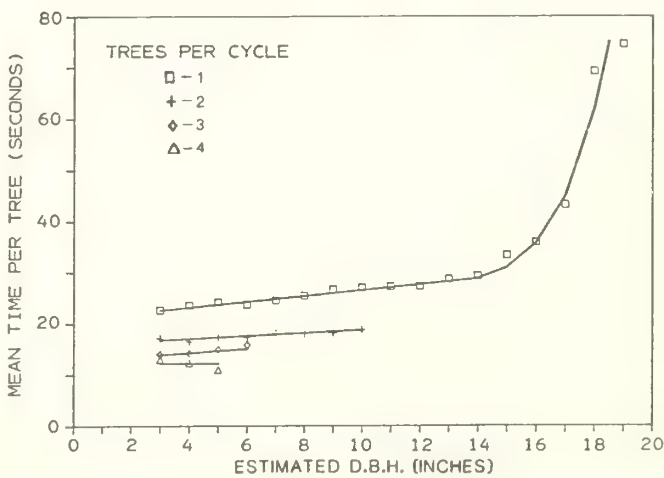

Figure 4--Mean fell and bunch time per tree vs. estimated d.b.h., for one, two, three, and four trees per cycle, Timbco system for entire study.

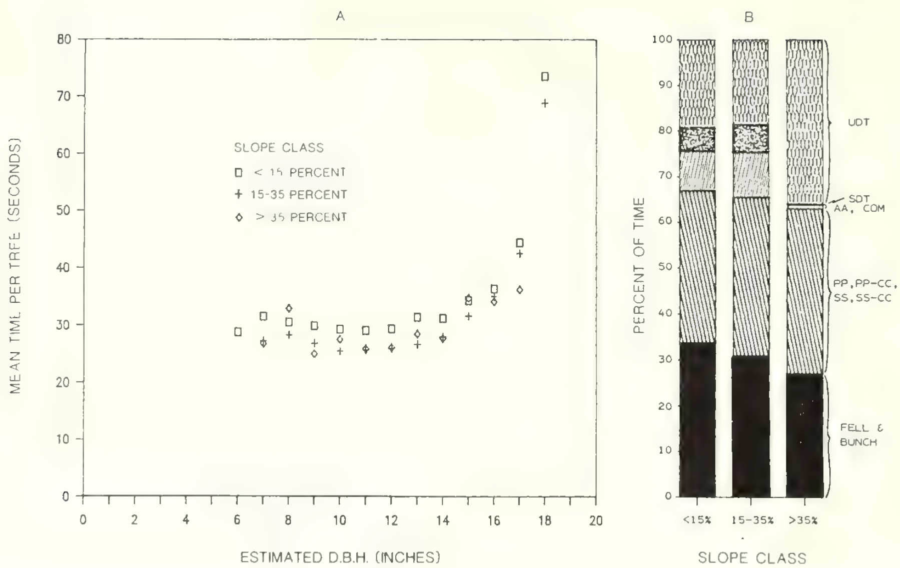

Figure 5--(A) Mean time per tree (single-tree cycles only) vs. d.b.h. and (B) activity distributions (percent of observed time) for three slope classes, Timbco system, close utilization units (8/8-10/15/84).

Figure 6 portrays information for the late autumn and winter part of our study, during which conventional sawtimber utilization was practiced. Note that mean times per tree for one-tree cycles in figure 6A are only slightly higher than in figure 5A, indicating that basic productivity was not affected appreciably or consistently by utilization standard, season, or slope. However, a comparison of the activity distributions in figure 6B with those in figure 5B shows considerable differences, with a much higher proportion of time spent for position-to-position and strip-to-strip moving relative to fell and bunch time in figure 6B. This is attributed to the need to move more frequently and longer distances to reach the larger, more widely spaced sawtimber trees when conventional utilization is practiced.

Comparison of figures 5B and 6B also indicates that Timbco availability was reduced during the conventional utilization period, perhaps due more to the adverse late autumn and winter weather conditions than to the utilization specifications.

BLACK CAT STAND AND TERRAIN CHARACTERISTICS

The stands in an area called Black Cat were more nearly stereotypical small-stem lodgepole pine than any others logged during our study. The Black Cat area lies about 13 air miles northwest of Missoula, MT. Two units, designated 25-84-2 and 25-84-3, were logged at this location. Unit 25-84-2 is about 44 acres, ranging in elevation from 5,550 to 5,750 feet. About

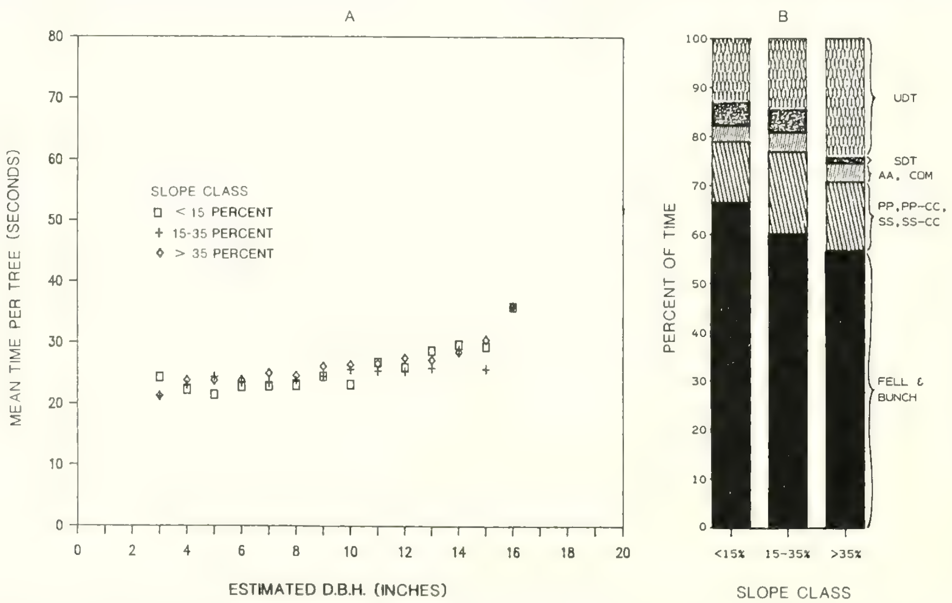

Figure 6--(A) Mean time per tree (single-tree cycles only) vs. d.b.h. and (B) activity distributions (percent of observed time) for three slope classes, Timbco system, conventional utilization units (10/15/84-2/7/85).

Table 1--Total stems per acre, 4 inches d.b.h. and larger, Black Cat Unit 25-84-2

D.b.h.	Douglas-fir	Western larch	Lodgepole pine	True fir	Total
4	4.8	49.9	161.2	0.0	215.9
6	14.5	20.4	114.7	0.0	149.6
8	0.0	10.0	57.5	2.4	69.9
10	4.3	4.4	29.4	0.0	38.1
12	3.0	0.0	5.2	0.0	8.2
14	0.8	0.8	0.0	0.0	1.6
16	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
22	0.0	0.6	0.0	0.0	0.6
24	0.0	0.3	0.0	0.0	0.3
26	0.0	0.2	0.0	0.0	0.2
28	0.0	0.0	0.0	0.0	0.0
30+	0.0	0.2	0.0	0.0	0.2
	27.4	86.8	368.0	2.4	484.6

Table 2--Total stems per acre, 4 inches d.b.h. and larger, Black Cat Unit 25-84-3

D.b.h.	Douglas-fir	Western larch	Lodgepole pine	True fir	Total
4	0.0	12.7	66.8	0.0	79.5
6	0.0	12.8	87.1	5.0	104.9
8	3.8	6.8	26.3	0.0	36.9
10	2.9	7.9	7.9	0.0	18.7
12	0.0	3.7	0.0	0.0	3.7
14	1.3	1.3	0.0	0.0	2.6
16	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0
30+	0.0	0.0	0.0	0.0	0.0
	8.0	45.2	188.1	5.0	246.3

80 percent of it is in the slope range of 15 to 25 percent. Another 10 percent of this unit is in the slope range of 10 to 15 percent; the remainder is in the range of 25 to 30 percent. Its aspect is dominantly southern. Table 1 is the stand table for Unit 25-84-2 based on pretreatment inventory on 11 variable radius plots.

Unit 25-84-3 lies just downslope from Unit 25-84-2. It is about 18 acres, ranging in elevation from 5,350 to 5,550 feet. Nearly 85 percent of this unit is in the slope range of 15 to 20 percent, and the remainder is in the range of 10 to 15 percent. Its aspect is southern. Table 2 is the stand table for Unit 25-84-3 based on pretreatment inventory on six variable-radius plots.

The logging prescription might be termed a seed-tree cutting, as about four western larch trees per acre were designated to be left in each unit; but, from a practical standpoint, these units were virtually clearcut.

Figure 7 shows the similarity between tree size distributions in the Black Cat units on the basis of d.b.h. estimates made during the time and motion study. (About half of the total stems cut in these units are represented.) Table 3 further compares the stands, showing that stand density in Unit 25-84-2 was about twice that in Unit 25-84-3.

It is reasonable to conclude that Units 25-84-2 and 25-84-3 were alike in most respects, with the exception of stand density.

Table 3--Statistics based on preharvest inventory, Black Cat Units 25-84-2 and 25-84-3.

Unit	Stand density	Volume	Basal area	Net volume
	Stems/ acre[1]	Ft^3/ acre	Ft^2/ acre	Bd ft/ acre
25-84-2	484.6	2,686.9	135.7	6,146.7
25-84-3	246.3	1,479.5	71.8	3,103.7

[1]4 inches d.b.h. and larger.

TIMBCO PERFORMANCE AT BLACK CAT

One of our primary interests in analyzing Black Cat data was to determine whether and to what extent the aforementioned difference in stand density affected the Timbco's performance.

Operators' records showed that the Timbco spent about 15.75 days or 166 hours in Unit 25-84-2 to fell and bunch 17,080 trees. On average, therefore, the mean total workday length was about 10.5 hours and mean production rate averaged about 1,085 trees per day or 103 trees per hour.

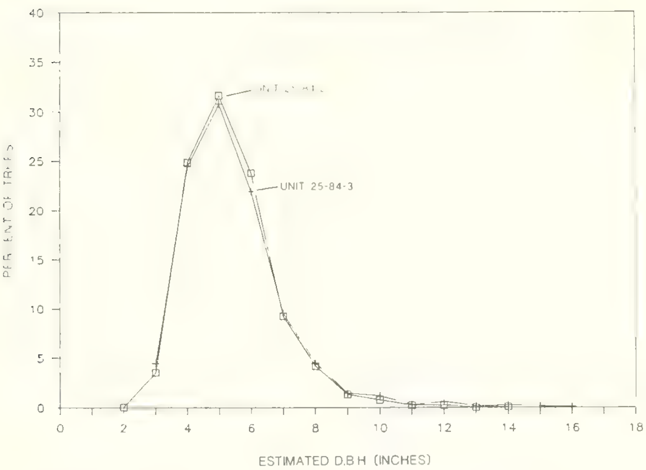

Figure 7--Tree d.b.h. distributions, Black Cat Units 25-84-2 and 25-84-3 (based on time and motion study estimates).

In Unit 25-84-3, about 4.75 days or 47 hours were required to fell and bunch 4,170 trees. Thus, the mean workday length in this unit was about 9.9 hours, and mean production rate was about 880 trees per day or 89 trees per hour.

Therefore, not only was the daily productivity greater in Unit 25-84-2--in part due to longer average workday lengths--but hourly productivity was also about 16 percent higher in Unit 25-84-2 than in Unit 25-84-3.

Time and Motion Study Results

Time and motion observations at Black Cat accounted for about 94 hours and nearly 11,000 trees distributed uniformly over the entire Timbco operating period. Figure 8 shows the distribution of the Timbco's time by activities, based on these observations; and, compared with figure 1, it shows somewhat greater availability and utility than the study average.

Average results such as shown in figures 1 and 8, however, fail to reflect the variations that occur in logging operations. For example, figure 9A shows the daily activity distributions at Black Cat, as well as unit and study summaries. (Note that the bar chart labeled "ALL BLACK CAT" at the extreme right in figure 9A corresponds exactly with the pie chart of figure 8.) Thus, observations over brief periods may be misleading; and it may be necessary to study a logging system over extended periods to obtain an accurate portrayal of its performance characteristics.

Figure 9B shows the percentages of total time and trees tallied by the Timbco operators that were accounted for by the time and motion study monitors, which may be used as a basis for assessing confidence in the corresponding results in figure 9A.

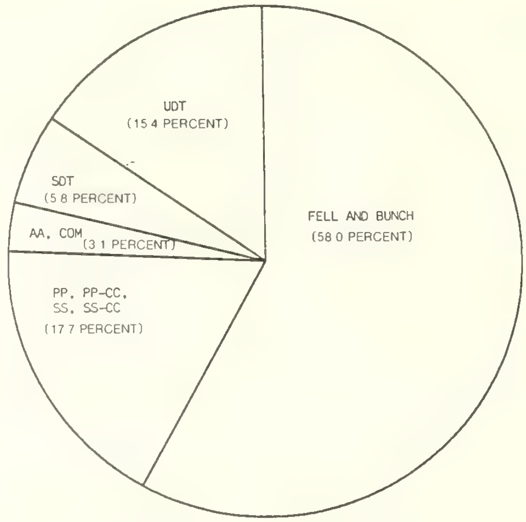

Figure 8--Timbco activity distribution (percent of observed time excluding lunch periods) at Black Cat.

About 93 percent of the observed trees were cut during the 58 percent of time labeled FELL and BUNCH in figures 8 and 9A, and the remaining trees were cut during the operations labeled PP-CC or SS-CC. Of the trees cut during the fell and bunch operation, about 30 percent were cut in one-tree cycles, about 50 percent in two-tree cycles, and the rest in three- or four-tree cycles. Mean times per tree for one-, two-, three-, and four-tree cycles were 24.1, 17.1, 14.2, and 11.7 seconds, respectively.

Figure 4 fairly represents the average basic productivity at Black Cat. Mean time per tree was about 18.5 seconds. Thus, out of an hour, $0.58 \times 3,600 = 2,088$ seconds were spent in the basic felling and bunching operation, yielding 2,088 seconds $\div$ 18.5 seconds per tree $\cong$ 113 trees attributable to the basic fell and bunch activity. In addition, 7 percent of the trees were cut during the PP-CC and SS-CC operations, for a total of $113 \div 0.93 = 121.5$ trees per hour. This is appreciably greater than the average of about 100 trees per hour shown by the operators' records; and it is consistent with the discrepancy shown in figure 9B--that the time and motion study accounted for only 44 percent of the total time, but 51.4 percent of the trees, tallied by the operators. It is not clear whether the operators' gross records contained errors, or if there was bias in the time and motion study causing an overestimate of Timbco availability or utility.

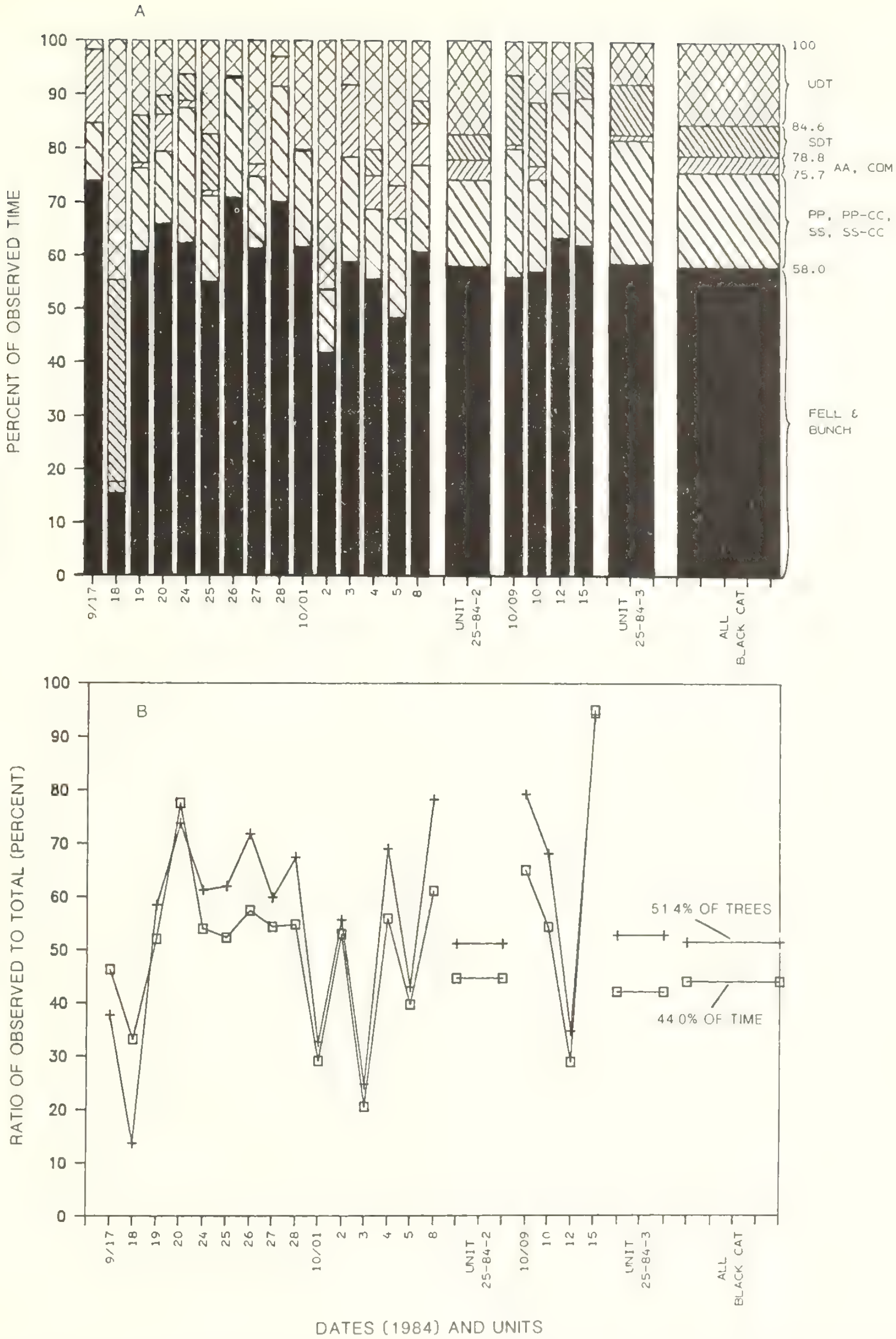

Figure 9--(A) Timbco activity distributions (percent of observed time excluding lunch periods) and (B) ratios of observed-to-total time and trees at Black Cat, day by day, unit by unit, and overall.

Figure 9A shows 17.5 percent UDT in Unit 25-84-2, but only about 8 percent UDT in Unit 25-84-3. Likewise, Timbco utilization was lower in Unit 25-84-2 (about 74 percent) than in Unit 25-84-3 (about 82 percent). However, the proportion of time spent in the fell and bunch activity was almost the same in each unit (a little under 58 percent in Unit 25-84-2 and a little over 58 percent in Unit 25-84-3). Obviously, a considerably greater proportion of time was spent in position-to-position (PP, PP-CC) and strip-to-strip (SS, SS-CC) moves in Unit 25-84-3 (about 23 percent of total time, or about 28 percent of basic productive time) than in Unit 25-84-2 (about 16 percent of total time, or about 22 percent of basic productive time).

The proportion of trees cut in single-tree cycles was lower in Unit 25-84-2 (about 27 percent) than in Unit 25-84-3 (about 38 percent) (fig. 10). Correspondingly, there were more multiple-tree cycles in Unit 25-84-2 (about 53 percent of trees cut in two-tree cycles and about 20 percent cut in three- or four-tree cycles) than in Unit 25-84-3 (about 44 percent of trees cut in two-tree cycles and about 18 percent cut in three- or four-tree cycles).

Basic productivity was also somewhat better in Unit 25-84-2 than in Unit 25-84-3, for which no explanation is apparent. In Unit 25-84-2, the mean times per tree were 23.3, 16.7, 14, and 11.4 seconds in one-, two-, three-, and four-tree cycles, respectively; and the mean value for the unit was about 17.9 seconds per tree. In Unit 25-84-3, the mean times per tree were 26.5, 18.6, 14.8, and 13.9 seconds in one-, two-, three-, and four-tree cycles, respectively; and the unit mean value was about 20.9 seconds per tree.

To summarize, in Unit 25-84-2, nearly 58 percent of the time was spent in the basic fell and bunch operation, during which the mean time per tree was about 17.9 seconds; therefore, there were $0.58(3,600)/17.9 \cong 117$ trees cut each hour during this portion of time. In addition, 6 percent of the trees were cut during PP-CC and SS-CC activities, for a total production rate of $117 \div 0.94 = 124.5$ trees per hour.

In Unit 25-84-3, about 58.5 percent of the time was spent in the basic fell and bunch operation, during which the mean time per tree was about 20.9 seconds; therefore, there were $0.585(3,600)/20.9 \cong 101$ trees cut each hour during this portion of time. In addition, 9 percent of the trees were cut during PP-CC and SS-CC activities, for a total overall production rate of $101 \div 0.91 = 111$ trees per hour.

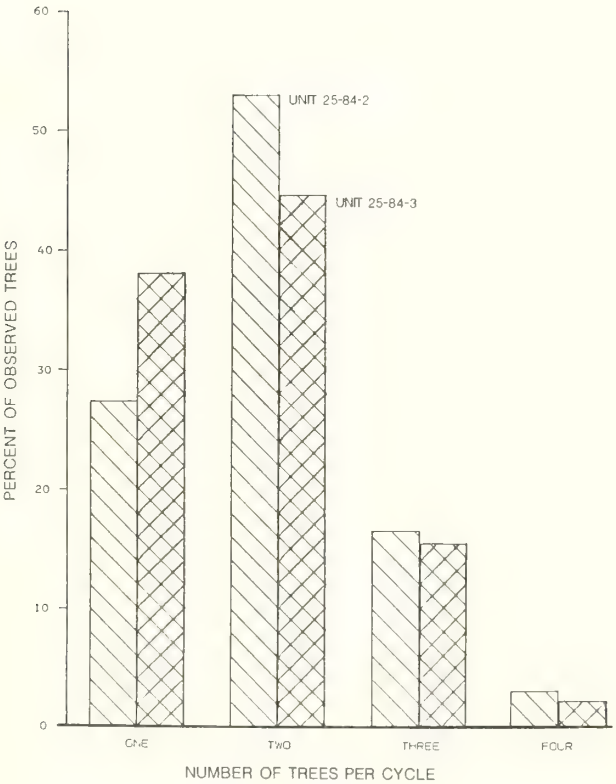

Figure 10--Percent of observed trees cut in one-, two-, three-, and four-tree cycles, Black Cat Units 25-84-2 and 25-84-3.

It is difficult to rationalize why UDT should have been different in one unit than in another. If UDT had been the same in each unit, then the proportion of time attributable to the basic fell and bunch operation would have been lower in Unit 25-84-3 than in Unit 25-84-2. For example, given about 75 percent utilization, the fell and bunch operations would have occupied about $58/74 \times 75\% \cong 59$ percent of total time in Unit 25-84-2, but only about $58.5/82 \times 75\% \cong 53.5$ percent of total time in Unit 25-84-3. Correspondingly, the production rate would have been $[0.59(3,600)/17.9] \div 0.94 \cong 126$ trees per hour in Unit 25-84-2, but it would have been only $[0.535(3,600)/ 20.9] \div 0.91 \cong 101$ trees per hour in Unit 25-84-3. So we conclude that the production rate in Unit 25-84-2 would have been nearly 25 percent greater than that in Unit 25-84-3, other things being equal; and we attribute this mainly to the difference in stand density.

What about stands without the larger Douglas-fir and western larch trees that were in the Black Cat stands? Considering only multiple-stem cycles (two-, three-, and four-tree cycles) the mean fell and bunch time was a little more than 16 seconds per tree. If 58 percent of the time still was spent in the basic fell and bunch operation, and if we could count on only 5 percent of trees being cut and carried in conjunction with PP-CC and SS-CC operations, then a production rate of about $[0.58(3,600)/16] \div 0.95 \cong 137$ trees per hour might be expected. (Indeed, production rates at Black Cat averaged 130 trees per hour during 2 days, based on operators' records.) With nominal workday lengths of 10 hours (as tallied at Black Cat), the daily production rate would be about 1,370 trees. In even denser stands with smaller mean diameters, it seems reasonable to expect daily production rates of at least 1,500 trees per day. However, the reader should be cautious about such speculations without confirming observations.

SKIDDING AND PROCESSING AT BLACK CAT

A Hahn Harvester system, supplied by grapple skidders and assisted by a loader, processed the trees previously felled and bunched by the Timbco. The Hahn Harvester, normally operated by two persons, delimbs and bucks trees up to about 24 inches in diameter. It uses a photocell and associated electro-mechanical devices to measure log lengths. Multiple-stem delimbing and topping can be performed, albeit with some sacrifice in the quality of delimbing. The loader is necessary to remove logs and delimbed boles from the outfeed end of the Hahn and to deck them or load them onto trucks. The infeed boom charges the Hahn with trees and also clears limbs and tops away from the infeed area and piles this debris to the side.

No separate studies of skidding productivity were conducted. Instead, skidding capacity was varied to approximately match the Hahn system's capacity.

Gross Productivity

At Black Cat, the Hahn system operators tallied 19 days or 158 hours (averaging about 8.3 hours per day) to process about 19,640 trees, for a mean gross production rate of about 1,035 trees per day or 124 trees per hour. For Unit 25-84-2, 15 days or 128 hours (8.5 hours per day) were required to process 15,720 trees (about 1,050 trees per day or 123 trees per hour). For Unit 25-84-3, 4 days or 30 hours (7.5 hours per day) were required to process 3,920 trees (about 980 trees per day or 131 trees per hour).

Seven hours of UDT were recorded by the operators, all of which occurred while processing trees from Unit 25-84-2. On the basis of "net" hours (excluding UDT) the production rates in Units 25-84-2 and 25-84-3 were virtually identical. Thus, because tree size distributions in the two units were essentially identical, there is no reason to distinguish between these units with respect to processing with the Hahn system.

Time and Motion Study Results

The time and motion studies accounted for about 89 hours and 10,670 trees, or over half the totals recorded by the Hahn system operators. Figure 11 shows that nearly one-fourth (23.4 percent) of the observed time was lost due to UDT. A little over half (52 percent) of the observed time was spent in the basic processing function (PROC = single-tree processing cycles and MPROC = multiple-tree processing cycles). Of the remaining time, about half (13.3 percent of observed time) was attributable to ancillary activities (AA), mainly slash or debris clearing and piling by the infeed operator. A small amount (3.1 percent of observed time) was spent for maintenance and other SDT, and the rest (8.2 percent of observed time) was attributable mainly to delays caused by running out of trees and waiting for the skidders to deliver more (DEL-OT).

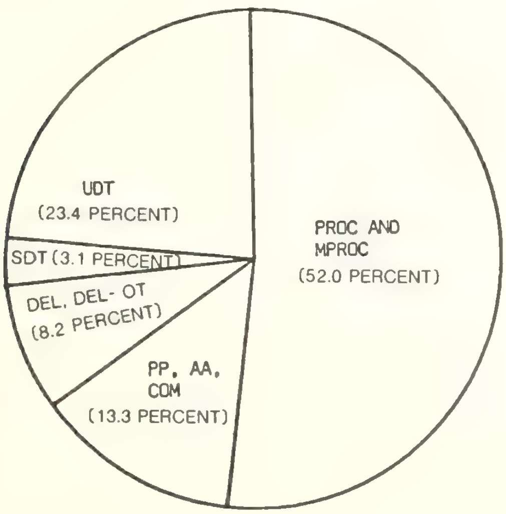

Figure 11--Hahn Harvester activity distribution (percent of observed time excluding lunch periods) at Black Cat. DEL-OT=delays due to being out of trees; DEL=other delays; PROC=single-tree processing cycles; MPROC=multiple-tree processing cycles.

During the 52 percent of time spent on PROC and MPROC, about 24 percent of the trees were processed in single-tree cycles--yielding about one-half sawlog per tree on average--and requiring a mean of about 36 seconds per tree. The remaining trees were processed in multiple-stem cycles, with an average of about 3.3 trees per cycle and a mean time of about 9.2 seconds per tree. Virtually no sawlogs were produced in multiple-stem cycles. Table 4 shows the proportion of trees and the mean times per tree vs. the number of trees per cycle for multiple-tree cycles only; and figure 12 shows the effect of mean d.b.h. on mean time per tree, for both single- and multiple-stem cycles (up to five stems per cycle).

Table 4--Percent of trees and mean time per tree vs. number of trees per cycle, multiple-tree cycles only, Hahn System, Black Cat Units

Number of trees/cycle	Percent of trees	Mean time per tree
		seconds
2	16.5	14.1
3	19.0	10.1
4	16.5	8.1
5	12.0	6.6
6	8.5	5.4
7	3.0	5.0
8	0.5	4.4
Overall[1]		
3.3	76.0	9.2

[1]Note that 24 percent of the trees were processed in single-tree cycles. The results shown here are for the remaining 76 percent of trees processed in multiple-tree cycles.

Figure 12 indicates a rising mean time per tree with increasing d.b.h., especially pronounced for one-tree cycles. Much of this increase for one-tree cycles can be attributed to an increase in the mean number of sawlogs per tree with increasing d.b.h. Measurement and bucking of sawlogs requires more time than mere delimbing and topping of pulp boles, because of the need for careful length measurements and adjustments. Figure 13 shows the relationship between sawlog-to-stem ratio and d.b.h. for the trees at Black Cat, which mimics the mean time per tree vs. d.b.h. relationship for one-stem cycles shown in figure 12.

A mean time of 15.65 seconds per tree was determined from the time and motion study data, resulting in a production rate of $3,600 \div 15.65 \cong 230$ trees per productive hour; but since only 52 percent of the time was spent in PROC and MPROC, the estimate of gross productivity is only about 120 trees per hour--nearly the same as the production rate of 124 trees per hour based on the operators' records.

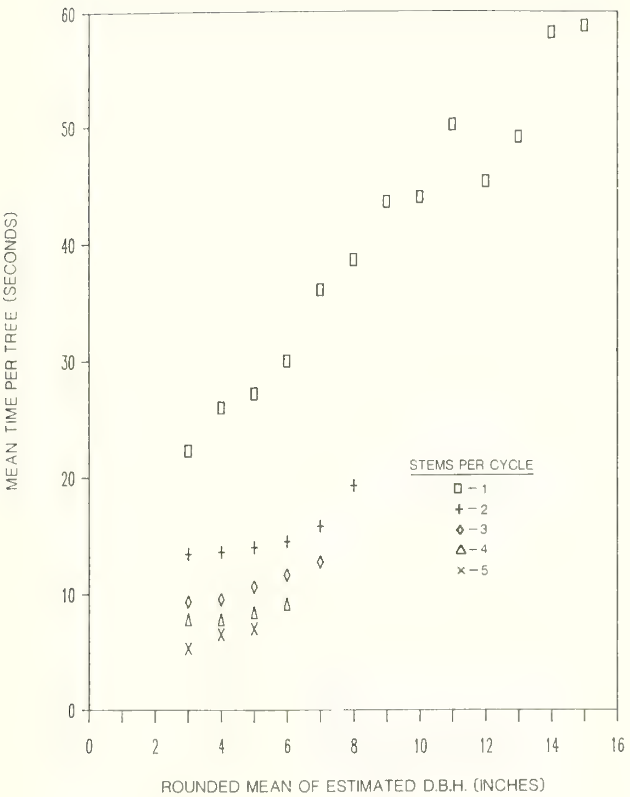

Figure 12--Mean time per tree vs. d.b.h., Hahn system, single- and multiple-stem cycles, Black Cat.

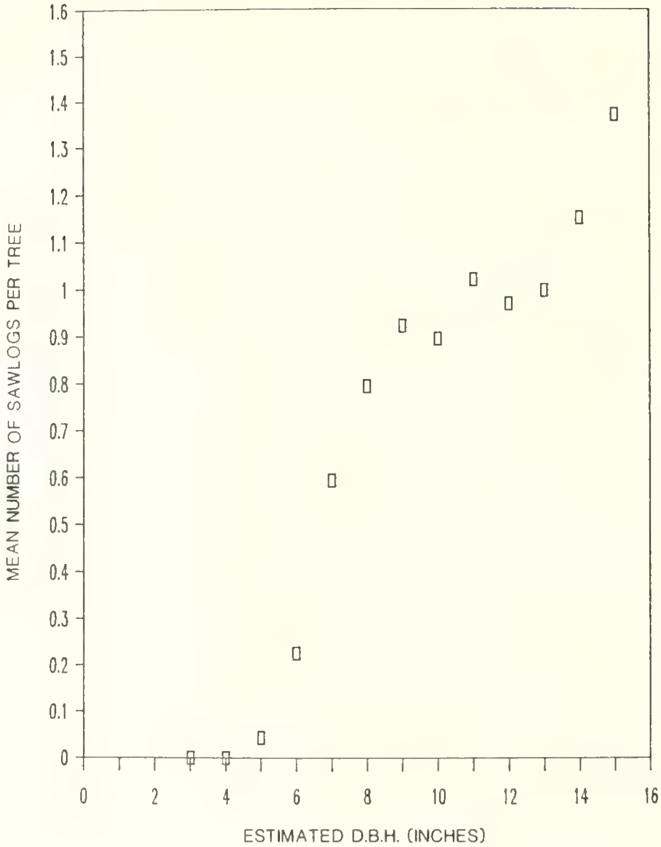

Figure 13--Mean number of sawlogs per tree vs. d.b.h., Hahn system, Black Cat.

Production Compatibility with Timbco

This analysis indicates that the Hahn system's production rate at Black Cat was somewhat greater than that of the Timbco. The discrepancy would have been even greater if skidding productivity had been slightly better (thus reducing or eliminating DEL-OT).

If only small trees were to be processed, without making sawlogs but merely delimbing and topping, then we might expect a mean time per tree about the same as that for multiple-stem cycles--9.2 seconds as derived in table 4. Thus, production rates as high as 3,600 ÷ 9.2 ≅ 390 trees per productive hour might be expected. Even with only 52 percent of the time spent in the basic activity of PROC and MPROC, this would result in a production rate of about 200 trees per hour or 1,600 trees per 8-hour workday, which is comparable to the previously derived daily production rate that might be expected for the Timbco in denser, smaller stemmed stands.

The Timbco could be operated at night; but skidding after dark is probably inadvisable from a safety standpoint, especially in steep terrain. Thus, production compatibility between the Hahn and Timbco systems seems reasonably good; and it appears that perfect compatibility is achievable--at least theoretically--by working the Timbco extra hours.

Material Balance

Gross production records at Black Cat showed an output of about 20,380 pulp boles and 2,470 sawlogs from 19,640 trees. The net sawlog volume was about 164,000 bd ft (Scribner) entailing 39 logging truck loads, for mean values of 63.3 logs or 4.21 thousand bd ft per truck load. The weight of these logs was 1,079 tons, averaging 27.67 tons per truck load and about 2.29 logs per ton.

The discrepancy between the Hahn and Timbco tree tallies of 19,640 and 21,250 trees, respectively, may reflect errors in tree estimates made by the infeed boom operator on the Hahn. When grabbing bunches of small trees, it is difficult to see all of them clearly. In contrast, the other Hahn operator can see the delimbed and topped boles relatively easily.

The ratio of pieces produced (22,850) to stems tallied (19,640) is 1.16 pieces per stem, based on the gross production data. However, from the time and motion study data, a ratio of about 1.09 pieces per stem was calculated, based on observations of nearly 11,000 trees. Thus, if we consider the ratio of 1.09 pieces per stem to be more reliable than 1.16 pieces per stem, we conclude that the Hahn system infeed operators may have underestimated the trees processed. Further, if we consider the estimate of total pieces (sawlogs and pulp boles) to be accurate,

then applying the ratio of 1.09 pieces per tree yields an estimate of the number of trees processed of nearly 21,000 trees--a number reasonably close to the Timbco operators' tally of 21,250 trees.

Of course, if the Hahn system operators' tree tally should have been about 21,000 instead of 19,640, and if their tally of 158 hours is accurate, then the gross production rate was about 133 trees per hour. This is considerably greater than the estimate of 120 trees per hour computed on the basis of the time and motion study results; and it implies bias in the time and motion study, suggesting that availability or utility was actually greater than concluded therefrom. Again, it is not clear whether the major cause of discrepancy was bias in the time and motion study or errors in the operators' records.

PULP BOLE CHIPPING

Our use of the term "pulp bole" is somewhat misleading. An original study objective was to utilize trees down to about 4 inches d.b.h., as well as the tops of larger trees from which sawlogs or plywood peelers were produced. We hoped that the Hahn Harvester could strip enough of the bark from these trees and tops to satisfy pulp chip quality standards--thus the term "pulp boles." Additionally, the limbs and other debris were to have been chipped for hog fuel.

As it turned out, the pulp boles could not be debarked cleanly enough to meet pulp chip standards, so the chips produced from them ended up as hog fuel. Moreover, the difficulties encountered in trying to chip the limbs and other debris were judged insurmountable.

Obviously, it would have been considerably more efficient to bypass the Hahn and chip whole trees, if only hog fuel chips were to be produced. Not only would there have been somewhat greater yield, but the cost of delimbing and topping would have been avoided. Nevertheless, we decided to proceed with the original plans for two reasons: (1) pulp chip quality standards may change in the future, making currently unacceptable chips acceptable and (2) there are circumstances in which chipping may not be desirable or possible, but where hauling of delimbed and topped "pulp boles" might be considered. Thus, information about delimbing and topping small trees was considered of sufficient importance to continue with the operation as originally planned.

The chipping system consisted of a Morbark Model 18 chipper, rubber-tired grapple skidder(s), and several chip vans, tractors, and drivers. Skidder and chip truck capacities were adjusted for reasonable compatibility with chipper productivity. No separate studies of skidder or chip truck productivity were undertaken. However, skidder turns were tallied to permit rough estimates of skidder requirements in other situations.

Gross Productivity

At Black Cat, where the road is relatively steep and winding, only 40-foot vans could be used. (Elsewhere, both 45-foot and 40-foot vans could be used.) Records maintained by the chipper operators showed that 16 workdays totaling about 132 hours (averaging 8.25 hours per workday) were required to chip the estimated 20,380 pulp boles produced by the Hahn system--yielding 127 van loads of chips, for an average of about 1 hour per van load and eight van loads per workday. A total of 3,152 green tons or 1,453 bone-dry units (BDU) were produced, averaging about 24.8 green tons or 11.44 BDU per van load. The mean net time per van load at Black Cat--excluding time spent for adjusting chipper position between vans, waiting for vans to arrive, UDT, SDT, and other matters, but including delays caused by running out of wood while chipping and having to wait for the skidder(s) to deliver more--was about 38.5 minutes, requiring a mean of about nine skidder turns per van load. Thus, less than two-thirds of the total time was attributed to van filling by the operators.

Time and Motion Study Results

Personnel shortages precluded detailed time and motion study of the chipping system at Black Cat. However, results obtained during operations near St. Regis immediately before the Black Cat operations should be applicable. Based on these results, figure 14 shows that about 60 percent of the time was attributable to van filling, of which about one-fourth (14.8 percent of total time) was lost due to delays caused by running out of wood. Net chipping time for 40-foot vans averaged only about one-half hour at St. Regis, and about 32.5 minutes for 45-foot vans (see table 5). If delays caused by running out of wood while chipping are included, the mean filling time for 40-foot vans at St. Regis was about 39.5 minutes, or nearly the same as the 38.5 minutes inferred from the operators' data at Black Cat.

Table 5--Chipping system productivity at St. Regis

Number of van loads observed	Van size	Mean fill time Gross	Net	Mean of skidder turns required per van load
		- - Minutes - -		
42	40-ft (11-12 BDU[1])	39.4	30.2	9.9
20	45-ft (12-13 BDU)	43.6	32.6	10.3

[1]Bone-dry unit (BDU) = 2,400 lb, bone-dry

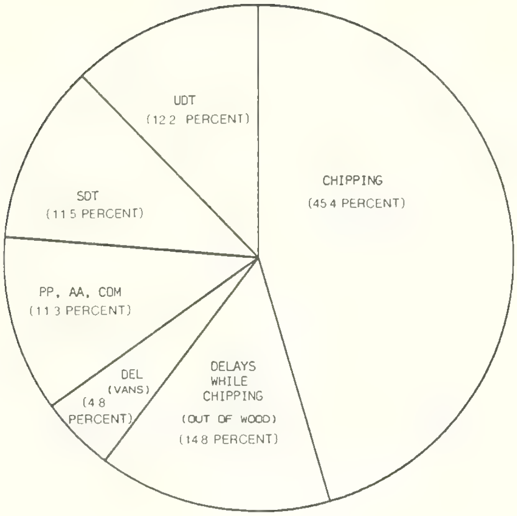

Figure 14--Chipping system activity distribution (percent of observed time excluding lunch periods) at St. Regis. DEL(VANS)=delayed due to being out of vans.

Production Compatibility with Hahn and Timbco Systems

Although the gross production records indicate reasonable compatibility between the chipping system and the Hahn processing system at Black Cat (16 days or 132 hours for chipping versus 19 days or 158 hours for processing), the time and motion study results suggest that the chipping system might be able to match the productivity of up to two Hahn systems in the right circumstances.

This is not to imply that the chipping system was operated inefficiently during our study. Nor do we suggest that skidder or van capacity could be increased to avoid delays without added cost. We merely imply that, if the chipper could be kept operating at its rated capacity, utilization of about 65 percent might reasonably be expected. In an 8-hour day, this would mean about 312 minutes of chipping, or about 10 van loads of chips per day. Had this been possible at Black Cat, the 127 van loads would have been completed in about thirteen 8-hour workdays, or in less than 70 percent of the time required by the Hahn system to process the pulp boles. By operating the chipping system overtime, productivity approaching twice that of the Hahn system would seem to have been readily attainable.

The Hahn system was handling large as well as small trees in our study, and producing sawlogs and plywood peelers in the process. With only small lodgepole stems containing no sawlogs and peelers, the production rates of the Hahn and chipping systems probably would have more nearly matched. However, as discussed earlier, the combination of delimbing and chipping may not be tenable without debarking as well.

The chipping system's productivity of 20,380 pulp boles in 16 days equals about 1,275 boles per day; and with the implied gain of 25 percent deemed possible by eliminating certain delays, a production rate of up to 1,600 boles per day might reasonably be expected. The Timbco should be able to fell and bunch about this many small-stem lodgepole pine trees, depending on stand density. Thus, in a whole-tree chipping operation in dense stands of small trees, there should be reasonably good compatibility between the Timbco and a chipping system of the type described here.

IN-WOODS DEBARKING

Our inability to satisfy pulp chip quality standards heightened our interest in the potential for in-woods debarking. An opportunity arose to study the performance of a Morbark Model 2250 debarker during a brief period of about 15 hours distributed over 4 days in January, 1985.

The debarking system consisted of the debarker, a hydraulic loader, and a grapple skidder. The skidder delivered bunches of whole trees to the infeed end of the debarker and roughly delimbed them with its blade. A sawyer topped the stems and removed any remaining limbs with a chainsaw. The sawyer also bucked the crooked stems into shorter, relatively straight segments when necessary. The limbs and tops were gathered by the grapple skidder and taken to the chipper for conversion into hog fuel. The skidder also occasionally pushed bark away from the debarker into waste piles.

Time and Motion Study Results

Figure 15 shows the proportions of observed time spent by the debarking system in various activities. Availability of the system was high; only 5.4 percent of the time was lost due to UDT, more than half of which was caused by a hose leak on the loader.

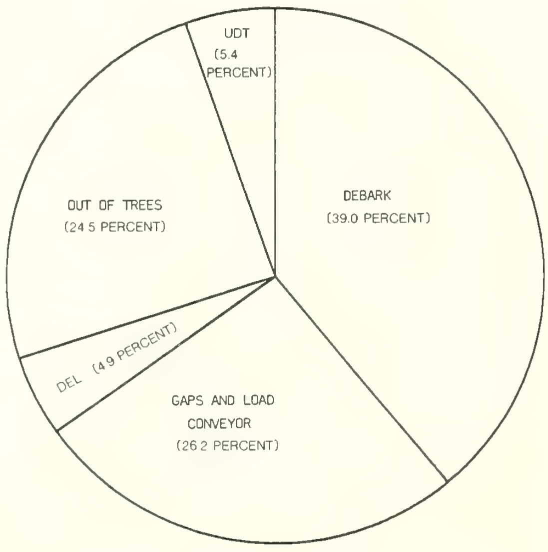

Figure 15--Debarking system activity distribution (percent of observed time excluding lunch periods).

Although availability was relatively high, utilization of the debarker appears low in figure 15. Only 39 percent of the total time (about 41 percent of available time) was spent in the basic debarking function, while another 26.2 percent of total time (27.7 percent of available time) was accounted for by gaps between the stems.

About 1,220 pieces were debarked requiring a mean time of about 17 seconds per piece. Gaps between pieces accounted for about 11.4 seconds per piece, on average. About 5 percent of the gaps, accounting for about 20 percent of gap time, were beyond the control of the debarker operator. These were caused by failure of the loader to supply the infeed conveyor of the debarker. The other 95 percent of gaps, accounting for 80 percent of the gap time (and averaging about 10 seconds per piece) were presumably controllable by the debarker operator.

Of the remaining 29.4 percent of total observed time, most was lost simply because the system was out of trees. The skidder was unable to keep the debarker supplied during about 24.5 percent of total observed time. Another 4.9 percent of the time was accounted for by various other delays--mostly waiting for the sawyer to complete delimbing and bucking tasks before the loader could perform its role.

We expected that feed rate while debarking would be inversely proportional to stem diameter. Thus, lengths and end diameters of the pieces were estimated. Based on these estimates, the mean diameter of each piece was calculated, and the aggregates of times and lengths for all stems within each mean diameter class were used to deduce mean feed rates. Figure 16 shows the relationship between these feed rates (expressed reciprocally in seconds per foot) and mean diameters; and the relationship weakly supports our expectations.

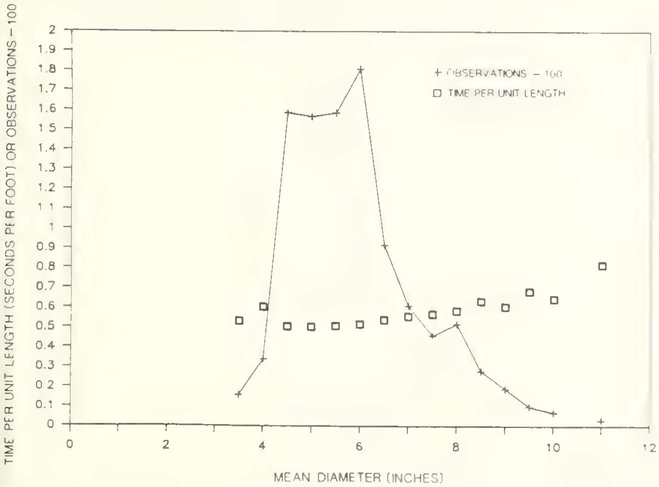

Figure 16--Mean time per unit length and number ot observations vs. mean stem diameter for the debarking system.

Excluded from figure 16 are those debarking cycles that contained unusual delays, such as occasional times spent reversing stems to achieve better quality; so this figure should be used for estimation purposes only with caution. Represented in figure 16 are 1,027 stems, or about 84 percent of all the observed stems. Mean stem length was about 30.8 feet and mean debarking time was about 16.5 seconds (or about 0.54 seconds per foot). But mean time for all the observed stems was about 17 seconds. From this it can be inferred that the remaining 16 percent of stems not represented in figure 16 required a mean time of about 19.5 seconds. Thus, if their lengths and diameters were distributed approximately as those represented in figure 16, it may be concluded that these "problem" stems required nearly 20 percent more time for processing.

Production Compatibility with Other Systems

In stereotypical small-stem lodgepole pine stands, where the stems are relatively straight, mean feed rates of at least 2 feet per second should be readily attainable with a debarker of the type described here. If stem lengths (exluding tops) averaged 30 feet, a mean time of 15 seconds per stem would be required. If delays caused by running out of trees and some of the other gaps between stems could be nearly eliminated, thereby increasing effective debarking time to about 65 percent of total time, then at 15 seconds per stem the production rate would be 156 stems per hour, or about 1,250 stems per 8-hour day.

It seems reasonable to expect fairly good compatibility between a debarking system of the type we studied and the other systems described here if operations are in small-stem lodgepole pine stands, and if minor adjustments in workday lengths among the systems are acceptable.

DISCUSSION AND SUMMARY

A major purpose of studies like ours is to provide a basis for predicting systems performance in future circumstances. Unfortunately, circumstances in timber harvesting are seldom repeated, especially in unmanaged forests in mountainous terrain. Also, harvesting equipment is operated by humans whose skills and motivation vary. Consequently, it is difficult to generalize and extrapolate to circumstances beyond those in which a study of this type is conducted.

By some standards, the Black Cat stands highlighted in this report would be considered to be dense and small-stemmed; nevertheless, they were not nearly as dense, nor were the trees as small, as many lodgepole stands. Therefore, while we consider our speculations regarding Timbco performance in other, "more typical" small-stemmed lodgepole stands to be sound, the reader should be cautious and seek numerous sources of information as a basis for predicting outcomes in new situations.

When clearcutting stands denser than Black Cat, it is reasonable to expect Timbco production rates at least as great as those reported here, all else being equal. However, while production rates may increase in terms of trees per unit of time, volumetric production rates may be lower, depending on tree sizes.

For thinning operations, it is considerably more difficult to predict Timbco performance on the

basis of this study's results. No doubt, production rates, in terms of trees harvested per unit time, would have been lower had the Black Cat units been partially cut instead of clearcut. But in stands considerably denser than those at Black Cat, especially if mean tree sizes were smaller, production rates as high as or even higher than those reported here might reasonably be expected in heavy thinnings where residual stand densities are relatively light. Obviously, the lighter the thinning and the denser the residual stand, the lower the expected production rate. Above certain residual stand densities, systems like the Timbco and associated skidders or forwarders cannot be used at all--depending on the degree of stand uniformity required--simply because of inadequate maneuvering room.

Although the Timbco can operate on steep terrain, it may not be able to negotiate road cuts in many situations (for example, it cannot climb vertical rock cuts). Thus, much mountainous terrain accessed by narrow roads incised into steep slopes may not be accessible to the Timbco, even though the terrain itself might be otherwise operable. Also, systems like the Hahn Harvester and Morbark chipper and debarker require sizable landings for efficient operation; so even if the timber can be cut and moved to roadside, mechanized processing and handling may require alternative technologies. Otherwise, it may be necessary to forward the trees significant distances to favorable landing sites.

While we recognize that the primary reason for predicting systems performance is to enable estimation of cost, we leave it to the reader to make such estimates on the basis of chosen assumptions regarding wage rates, equipment ownership and operating costs, and other factors.

Technologies like the Timbco provide the advantages of mechanization in circumstances where harvesting was formerly possible only with less efficient and more hazardous methods; but there are many mountainous areas where obstacles to mechanized ground-based timber harvesting remain to be overcome.

ACKNOWLEDGMENTS

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PREDICTING THE PERFORMANCE OF ALTERNATIVE HARVESTING SYSTEMS IN SMALL TIMBER

William R. Taylor

ABSTRACT: Discusses a systematic approach for predicting performance of alternative small-timber harvesting equipment and systems and describes the steps necessary to evaluate new equipment or new harvesting methods. Systems analysis and synthesis are required for the prediction of overall productivity and costs. Sensitivity and risk assessment are also addressed.

INTRODUCTION

The problems associated with the timber industry in general, and lodgepole pine in the Rocky Mountain area in particular, significantly impact large portions of our society. The "good stuff" next to the road is gone! Harvesting relatively small timber from steep slopes in very remote areas will likely require new technology or at least significant variations of the more traditional approaches. Each new piece of equipment will generate its own enthusiastic supporters, as well as doubters. Invariably, its success or failure will depend upon its productivity and its associated cost. The problem is that managers generally want to see productivity and cost data before they commit to any new methods and equipment. This frequently requires the use of models to predict the future performance.

SYSTEMS MODELING

Because models are but abstractions of the things they represent, they can take on a variety of forms: pencil and paper calculations, a computer program, a physical likeness, and so forth. Computers are excellent for this type of activity since they can make millions of calculations in seconds in response to changes in input data (Taylor n.d.).

The types of models frequently used to predict performance and cost data for harvesting equipment usually involve a computer. This does not mean that they need be complex to be accurate or effective. A macro-to-micro approach is recommended.

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William R. Taylor is Professor of Industrial and Management Engineering at Montana State University, Bozeman, MT. He is a registered professional engineer in Montana.

Sometimes called a "top-down" method, the macro-to-micro approach moves from a general statement of the system to one that provides more and more detail as the model is further developed. The advantage of this approach is that the model provides useful information from its inception without requiring that it be fully developed and completed. In case resource constraints such as limited time or money prohibit further model enhancement, much can usually be learned from the model even though it is not completed in terms of details. For this approach to be successful, it is essential that a "systems approach" be used.

SYSTEM DESIGN

If a model is to accurately predict performance and costs it must give a valid portrayal of what it represents. That is, the system on paper (or in a computer) must behave the same as the equipment in the field. This suggests that before seeking answers on productivity and cost, one should seek a thorough understanding of the problem at hand, the equipment, and how the equipment relates to or impacts other equipment and people. Many models do not work because the analysts do not take the time to really understand the equipment and the environment in which it must operate.

The Operating Environment

Equipment designers generally have a particular environment in mind when they create new machines. Obviously, rubber-tired skidders do not work as well on steep terrain as they do on relatively flat ground. To structure a good model, the analyst must begin with a thorough understanding of the harvesting site and timber characteristics. Factors such as size of the area, slope of the terrain, amount of down timber, top and breast height diameters, heights, species, and count data help define the problem. One excellent method for evaluating new equipment is to identify a cutting unit and its related inventory information from cruise data. Then compare productivity and cost data related to harvesting the cutting unit using the new equipment with that of present or more traditional approaches. This helps establish a benchmark on performance.

Understanding the Equipment

It is impossible to model a piece of equipment without a complete knowledge of how it works. It is important to read the equipment specifications

and operating instructions and talk to those who have operated the equipment. Better yet, acquire field data on productivity and costs from the equipment manufacturer, the Forest Service, or others. Frequently, sales literature will offer a video tape of the equipment operating. If so, get the tape and view it.

The kind of information needed to construct a model includes:

- What does the equipment do (and not do)?
- How does it do it?
- Are there other ways to utilize it?
- What is its production rate?
- What limitations does it have?
- What are the nominal factors influencing performance and their range?
- What operator skill level and training is required?
- What are the initial costs, operating and maintenance costs, and so forth?

With a thorough understanding of the equipment and how it operates, as well as the environment in which it must function, attention must be focused on how this new equipment or method will impact other components of the harvesting system.

Interfacing the Equipment

Frequently in timber harvesting, a machine is significantly impacted by the equipment immediately "upstream" from it, and likewise it affects those operations that follow it. It is common in the logging industry to find equipment idle because it is waiting for another machine to do its job. Also frequently observed is a piece of equipment that is so overloaded that work is queuing up in front of the machine, resulting in a bottleneck in the production process.

These kinds of problems can be avoided (or at least minimized) by examining not just the new piece of equipment but the system in which it must operate. By using a "systems approach" it is possible to balance the production rates of each piece of equipment and increase system productivity.

SYSTEMS MODEL

A typical systems model for timber harvesting is shown in figure 1. Down the left-hand side the main elements of the model are identified as "Inputs" to the model, the "Activities" within harvesting, and the results or "Outputs" from the model.

The Input section basically identifies the model time, cost, and scale factors that are unique to a particular problem. For example, inputs to the Felling activity include the cycle time per zone, number of trees per zone, cost per hour per zone, average tree size and setup time, and cost per zone. This allows a cutting unit to be partitioned into several zones each having unique characteristics. The cycle time represents how long it takes to cut a tree. The user would obviously input different values for a sawyer and a feller-buncher. Building a generalized model allows it to be used for a variety of situations. Similar input data is required for each of the activities of the model.

The timber harvesting process generally follows the sequence shown for activities in figure 1. In some cases a particular activity may be almost

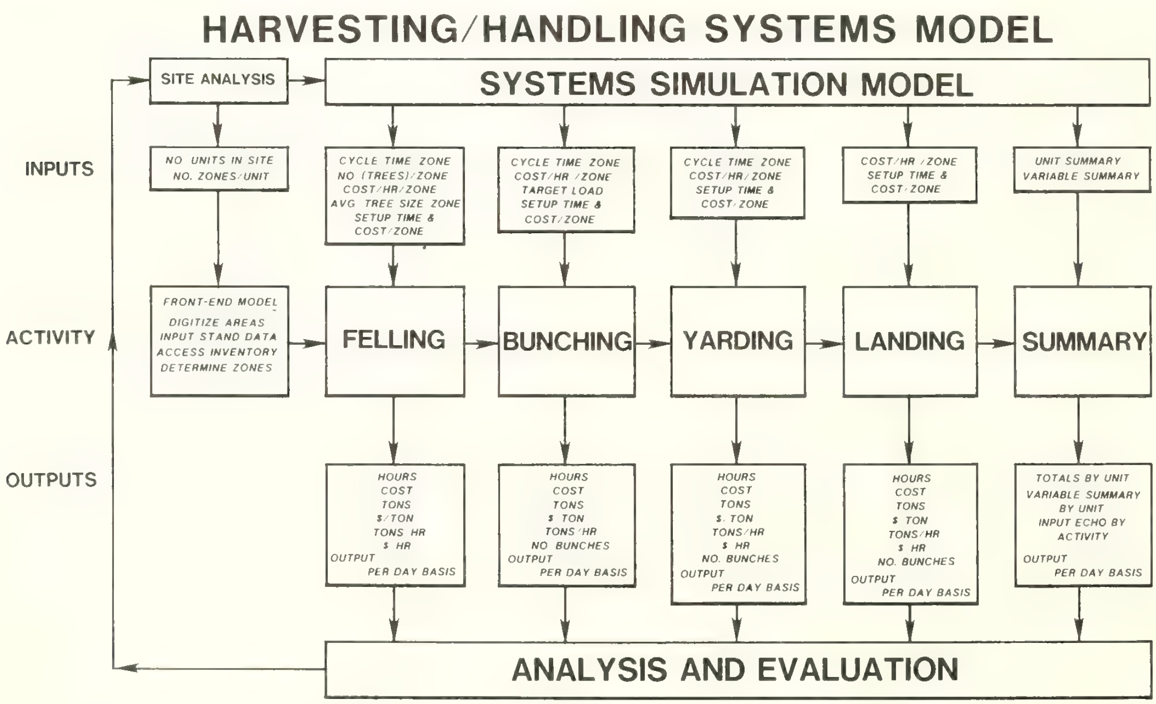

Figure 1--This schematic illustrates a typical systems model for timber harvesting.

nonexistent. For example, when helicopter yarding is involved, there may not be much bunching. However, chokers would be attached to trees and this could easily be handled as a bunching activity. The activity sequence in figure 1 thus does describe most harvesting situations.

The calculations involved for each activity are really rather simple, but they do lead to sound total productivity and cost data. For example, if one knows the number of trees in a zone, the cycle time per tree, and the cost per hour, the product of these terms yields the cost of the activity for that particular zone. This concept will be illustrated further with an example. Outputs from the model provide information regarding costs and productivity. For example, relative to a particular zone of the cutting unit one can determine the time and costs related to an activity along with the cost per ton, dollars per hour, tons (or board feet) per hour, and so forth. These data provide the basis for analyses and evaluations. If the data from each activity are summed from felling through loading, overall site, cutting unit, or zone, analyses can be made. This makes it possible to compare productivity and cost data for a particular site or cutting unit (when one or more of the activities is accomplished with new equipment) with a more established or traditional approach.

An Example

Frequently, one of the major obstacles to using models is the lack of good, accurate input data. The data in figure 2 illustrate how one might develop the "cost per hour" for a piece of equipment such as a feller-buncher.

Machine: feller-buncher
Initial Cost: $150,000 = P
Useful Life: 5 years
Salvage Value After 5 Years: $30,000 = L
Overhaul: $15,000 after 3 years
Interest Rate: 10 percent per year
Operating Costs: $29,000/year (calculated as follows)
(150 days/year)(9 h/day)($20/h) = $27,000/year
plus other miscellaneous costs = $ 2,000/year
Total Annual Operating Costs = $29,000/year

The interest rate of 10 percent is sometimes called a Minimum Attractive Rate of Return and represents a worth of money to the investor. He expects to earn at least 10 percent by investing in this machine. The first step in determining the "cost per hour" is to convert all of the data in figure 2 into an equivalent uniform annual cost. This is done by using interest factors that take into account that money has time value (White and others 1977).

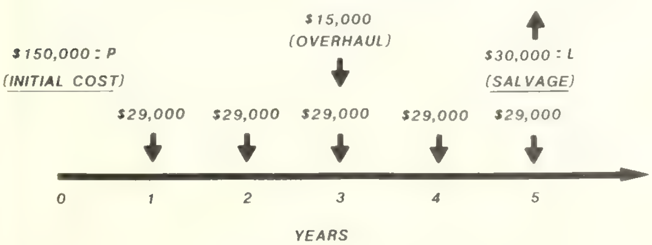

Figure 2--Illustrated are the base cost data needed to calculate the hourly cost of a feller-buncher with a useful life of 5 years. P = initial cost; L = salvage value after 5 years.

Three different interest factors are used in this particular calculation: (1) Capital recovery factor designated (A/P,i,n), (2) Single payment compound amount factor (F/P,i,n), and (3) Sinking fund deposit factor (A/F,i,n). Each of these interest factors is simply an algebraic expression involving the interest rate per period, i, and the number of periods, n. "P" represents a single, lump-sum amount of money at the "present" time, while "F" represents a lump-sum amount of money at some "future" time. When the same amount of money flows each period, it is called a "uniform series" and is designated "A". The interest factors permit the transforming of money at one point in time into an equivalent pattern at a different point in time. For example, the $150,000 initial cost in figure 2 can be transformed into an equivalent amount per year by multiplying it by the capital recovery factor as follows:

$150,000 (A/P,10 percent,5) =
$39,569.62 per year for 5 years.

The algebraic expressions for these interest factors are as follows:

Interest factor	Symbol	Equation
Capital recovery	(A/P,i,n)	$\frac{i(1+i)^n}{(1+i)^n-1}$,
Single payment compound amount	(F/P,i,n)	$(1+i)^n$,
Sinking fund deposit	(A/F,i,n)	$\frac{i}{(1+i)^n-1}$

Each term in the following equation converts an amount from figure 2 into an equivalent annual amount over a 5-year period.

Annual Cost = $150,000 (A/P,10 percent,5) + $29,000

+ $15,000 (F/P,10 percent,2) (A/F, 10 percent, 5)

- $30,000 (A/F,10 percent,5)

Annual Cost = $39,570 + $29,000 + $2,973 - $4,914 = $66,629/year

Hence, the dollar-time scale in figure 2 can be replaced by (is equivalent to) the one in figure 3.

Dividing 150 working days per year into the $66,629 per year yields a cost per day of $444.19 for owning and operating the machine. Dividing 9 hours per day into $444.19 yields $49.35 per hour. This is the number required as input to the model.

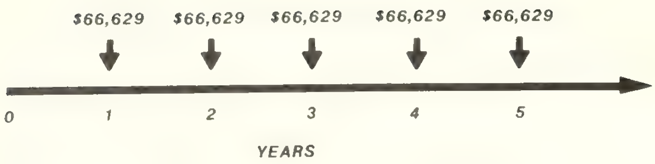

Figure 3--Converting cost data presented in figure 2 to an equivalent uniform annual cost results in the costs shown here.

Obviously, one should include all relevant costs when making these calculations. Costs such as those involved with setup, transportation of the equipment to and from a site, overhead, insurance, and so forth easily could be included.

Now, consider the kind of calculations to be made for each activity in the model. Suppose the feller-buncher was used to harvest a zone within a cutting unit that contains about 300 trees and that the cycle time is 1 minute per tree. Typical cost and productivity calculations are illustrated below:

Cost = (300 trees/zone)(1 min/tree)(1 h/60 min) ($49.35/h).

Cost = $246.75/zone.

Productivity = (300 trees/zone)(1 min/tree) (1 h/60 min).

Productivity = 5 h/zone.

Production Rate = (1 tree/min)(60 min/h) = 60 trees/h.

The calculations are simple with the aid of "dimensional analysis." By simply including the units along with the numbers, one can cancel terms until the desired result is obtained on the units.

SYSTEMS ANALYSIS

A well-constructed model can be extremely useful as a planning tool. One of its primary uses is to analyze the impact of "changes in the input" on the output. For example, suppose that the analyst is not really comfortable with the $20 per hour figure for operating cost. Suppose it is $40 per hour. What effect will this have on the cost of felling per tree? Or, suppose that the cycle time is 2 minutes per tree rather than 1. How will this change the queue of trees in front of bunching or yarding? The ability to play "what if" with a good model allows one to appreciate the risk involved in investing in a new piece of equipment.

In other industries managers frequently require three different scenarios to be presented: (1) the best case, (2) the worst case, and (3) the most probable case. The best case assumes that all costs will turn out to be on the low side and that productivity data will be very high but reasonable. In other words, if everything goes well this analysis would indicate a very optimistic point of view. A worst-case scenario would assume that everything will go poorly and would result in a pessimistic outlook. Thus, the manager has a range from worst to best with the real outcome probably somewhere in between. The most probable scenario presents the most likely values and should be the way the analyst really believes things will occur.

CONCLUSIONS

Unfortunately, investors and managers generally need to know what the future holds before making a decision regarding new equipment or methods for harvesting timber. There never seems to be enough time or information available when contemplating such a decision.

A model for predicting performance of timber harvesting equipment is rather simple. It does not require sophisticated mathematics or complex submodels to obtain good answers. It does require a thorough understanding of the equipment, its environment, and the system in which it is to operate. It also requires sound, accurate input data if the output is to be realistic and meaningful. It is helpful, but not necessary, if the model can be placed in a small computer since this will speed up the calculations and facilitate sensitivity analysis; that is, changing input information describing specific variables to observe effect upon productivity.

Although it will require some thought and time to develop the model, systems analysis works. It is an excellent way to assess risk. (When you think of it, about the only other way is to listen to what you or someone else has learned from past experience.) Using dimensional analysis to assist in determining how to calculate the desired output really simplifies the thought processes and reduces the time required to construct the model. To say that you don't believe in models because you don't believe anyone can predict all of the costs begs the question. We have no choice. The future is where we all will spend our time, and anticipating what is out there is required in some fashion every time we evaluate new equipment. Give modeling a try--you might just get hooked on its simplicity and effectiveness.

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A NEW HARVESTING SYSTEM FOR STAGNANT STANDS OF LODGEPOLE PINE

Richard Karsky

ABSTRACT: The Forest Service would like to reduce the cost of converting large tracts of small-stem, stagnated lodgepole pine stands into more viable commercial timber-producing stands. The wood chunker and the tree harvester described here are being developed to make such conversions cost-effective and to utilize the biomass that is removed. The tree harvester uses a swath mowing concept to cut 300 to 600 trees per hour, which are converted to chunks by the chunkwood chipper.

INTRODUCTION

The Intermountain region of the United States has a significant problem with large tracts of stagnant stands of lodgepole pine. Typically, these stands have such large numbers of stems per acre that their growth has stagnated before the trees are merchantable. In addition to the utilization problem, these stands are vulnerable to fire and insects because the trees are under stress. Treatment by removing the existing trees and establishing more productive stands is too costly because of inefficient harvesting methods for this material and a lack of markets for the resulting biomass.

The Forest Service Missoula Equipment Development Center (MEDC), Missoula, MT, has begun seeking solutions to the problem of recovering and utilizing the biomass from these problem stands in the Intermountain West. Increased demand for fuel wood has created a potential market that opened the door to solving this problem, if cost-effective methods of recovering the available biomass can be found.

A major potential market in this region is the electricity-generating industry. Early discussion with power company personnel has indicated they would prefer an energy wood particle larger than the coventional wood chip. Chunkwood technology may meet this demand. The combination of a tree harvester now in development and a specialized chunkwood processor may make removal operations in stagnant stands more economical and better suited to fuel use.

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Richard Karsky is a mechanical engineer, Missoula Equipment Development Center, Forest Service, U.S. Department of Agriculture, Missoula, MT.

WOOD CHUNKER

Development of the wood chunker (fig. 1) is a continuation of wood processing equipment research accomplished by Forest Service personnel at the North Central Forest Experiment Station laboratory at Houghton, MI (Arola and others 1983). "Chunkwood" is the name given the wood particles produced by the chunker--particles that can be several inches long and wide. Chunkwood production offers a number of advantages over production of conventional hog fuel chips. The chunker uses one-third the power per ton of material used by conventional chippers, the larger particles have higher bulk density and more weight per vanload than chips, the larger particles promote increased drying with reduced spontaneous combustion hazard, and fewer fine materials should reduce particulate emissions during burning. Blades on the chunkwood chipper tolerate more trash with less sharpening than conventional chipper blades. In addition, the long particle length parallel to the grain makes chunkwood a potentially suitable material for further mechanical reduction into flakes for waferboard or particleboard products. Particle length parallel to grain can be varied from 1 to 5-1/2 inches.

Figure 1--Wood chunker and loading conveyor.

The prototype chunker is based on the concept of an involuted disc slicer originally conceived by forest engineering project scientists in Houghton, MI (Mattson and others 1985). The

cutter wheel is a 2-inch-thick disc 42 inches in diameter. Detachable blades bent on an 18-inch-diameter radius are mounted perpendicular to the surface of the disc. Either two or three equally spaced blades are used. The leading edge of each blade is set at a greater radial distance from the center of disc than the trailing edge (fig. 2), so the trailing edge curves inward with respect to the leading edge. The blades are tapered so the leading edge projects about 1 inch from the surface of the disc, while the trailing edge projects about 13 inches.

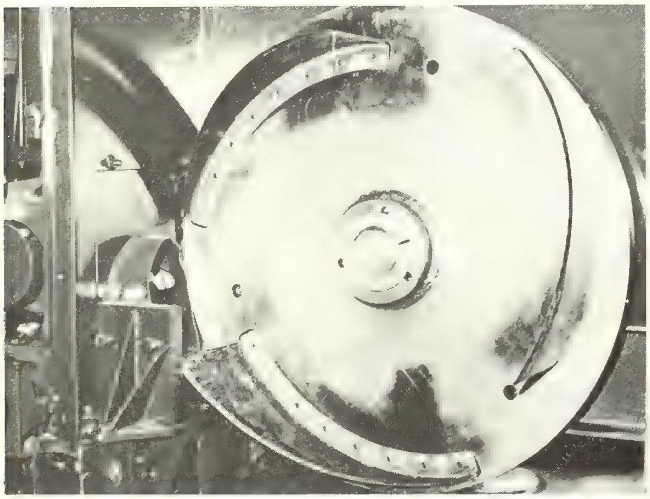

Figure 2--Cutter wheel with rear of cutting blades closer to center of wheel than the forward edge of blade (rotation counterclockwise).

Material to be cut is fed through a rectangular anvil horizontally secured to the infeed frame. The anvil is located near the rim of the disc, but offset from the plane of the disc to match up with the cutting blades. The center of the anvil is positioned slightly to the right of the disc center to obtain the desired entry and exit of the blades. The anvil is contoured to provide slight clearance between it and the blades as the chunks are severed from the workpiece.

Four hydraulically powered feed rollers positioned immediately ahead of the anvil feed material directly into the cutter, then a conveyor moves the chunkwood from under the cutter to a second conveyor. The secondary conveyor loads the material onto a truck (fig. 1). This differs from a conventional chipper operation in that the processed wood is conveyed rather than blown into a chip van. The cutter wheel revolution per minute can be varied, which affects the length of the chunk produced and the rate at which material can be fed into the chipper.

The initial blades were made of 4140 annealed alloy steel. After 6 hours of use they were resharpened because there was about 1/8 inch of wear on the blades starting about 4 inches up from the bottom. The blades were slightly bent from about 4 inches up on the cutting edge diagonally across to the trailing edge of the blade at the disc surface. The blades were replaced with blades made from T-1 steel.

Testing

In October 1985, the machine was demonstrated and tested in the Colville National Forest, WA (Karsky 1986). A load of green logs 8- to 12-inch d.b.h. and material 4- to 6-inch d.b.h. from dry slash piles (about 56 tons of material) were chunked. The machine operated for 7-1/2 hours and used 85 gallons of fuel. The blades were not sharpened and did not bend; however, they did become almost too hot to touch. The cutter wheel was operated at 160 to 250 revolutions per minute, producing an average chunk 2-1/2 to 3-1/2 inches long, parallel to the grain (fig. 3).

Figure 3--Chunks produced by wood chunker. Average thickness is 2-1/2 to 3-1/2 inches.

A two-blade cutter wheel was installed to replace the three-blade wheel. The machine was then operated in the Lubrecht Experimental Forest, MT, in November 1985. The chunks were 3-1/2 to 4-1/2 inches long--an average of 1 to 1-1/2 inches longer than those produced by the three-blade cutter, but shorter than expected.

A series of tests were run in spring of 1986 with different blade offsets or pitches, and different edges on the blades. The offset affects how much closer the rear of the blade is to the center of the cutter wheel than the front point (fig. 2). Three offsets were tried: 0, 2-1/2, and 4 inches. Two edges were tried: a single bevel that has the blade sharpened on one side only, with the sharp edge closest to the anvil; and a double bevel where the blade is sharpened equally on both sides, with the cutting edge in the middle. Each of the offsets and blade edges required different anvils, so these had to be changed when each combination was tried. The main objective of these tests was to improve the feed rate through the machine and to produce longer chunks.

Test Results

The single-bevel knife edge deflected the blade into the anvil when chunking material larger than 6 inches in diameter. Even with the larger offset, the double blade appeared to deflect slightly into the anvil when chunking large-diameter material. This would have to be monitored in future testing. About 52 horsepower was required to cut a green 8-inch-diameter log. Recommendations are to use double-bevel blade edges with either the 2-1/2-inch or 4-inch offset. A maximum average chunk length of 5-1/2 inches could be obtained with the 4-inch offset cutter. With the standard offset of 2-1/2 inches, a maximum average chunk length of 4-1/2 inches could be obtained. Shorter lengths could be obtained by speeding up the cutter wheel. The feed rate using the two-bladed cutter wheel with the 4-inch offset appears to be at least 20 percent greater than the rate using the two-bladed cutter wheel with the standard 2-1/2-inch offset.

Chunking small-diameter wood is a viable alternative to chipping. It offers new opportunities for utilizing small timber and creates a new market for commercial chunking machines. Commercialization of this technology should help utilize currently marginal wood resources, and should contribute to achieving improved stand management in small-stem stagnated stands.

TREE HARVESTER

The basic concept of the tree harvester now under development is similar to that of an agricultural reaper. The concept was developed by the Prince Albert Paper Company, Prince Albert, SK, which operates one machine fabricated to evaluate the concept (fig. 4). The tree harvester is limited to maximum slopes of 15 to 20 percent, but a large part of stagnant lodgepole pine stands are on relatively level ground. The machine functions as a continuously moving feller-buncher, not as a "stop and go" conventional feller-buncher (fig. 5). It mows down trees with a large circular saw while traveling along the periphery of a stand. The harvested trees are accumulated and subsequently unloaded as a bunch, with the butts in line. Its production rate is estimated at 300 to 600 trees per hour, depending on stand density. This is about three times as great as a conventional feller-buncher. Prince Albert Paper Company reports harvest rates of about one-half acre per hour with their machine, called the A line tree swather (Heidersdorf 1982).

Initially, the new tree harvester was to be a purchased machine already in production. The production machine did not materialize, so a contract was negotiated with a firm to build a machine. However, in December 1985, the proposal was withdrawn and MEDC was directed to build the machine.

Seven concepts with many variations were considered and evaluated by MEDC. These concepts included trailer units, two-joint articulation schemes, a displaced remote cab, operating the unit in reverse (similar to the Prince Albert Paper Company's model), and extended-wheel arrangements to offset the drive system. A Timberjack 520A rubber-tired skidder-forwarder was purchased as the prime mover for the swather and will be incorporated into the design. The final design will have the frame of the Timberjack 520A extended about 12 feet and offset 4 feet to one side. The saw will be located off to one side, slightly behind the operator. Only one operator will be required to control the harvester. The major components of the tree harvester have been ordered. Fabrication will begin in fall of 1986 with a target completion of the machine in summer of 1987. The machine will be operated at the MEDC test area and any deficiencies discovered after the initial operation will be corrected. The machine will then be shipped to the Colville National Forest in Washington for operational testing.

Figure 4--Prince Albert Paper Company A-line tree harvester.

Figure 5--Multiple stem felling with A-line tree harvester.

The MEDC tree harvester will be similar to the Prince Albert A line tree swather. The Prince Albert swather basically consists of a trailer with a side-mounted saw towed behind a Clark 668 skidder (fig. 4). The trailer includes an enclosed cab for the swather operator who controls the trailer's functions. This operator communicates with the skidder driver through a horn-signaling system.

A gooseneck at the front of the trailer is attached to a slide plate on the skidder with a ball-and-socket. This arrangement allows the operator to shift the 36-inch swath width +12 inches.

As the machine travels along the face of the stand, the swather operator moves the trailer in and out and selects the trees to be cut. A compeller or rotating arm aligned with the outer edge of the saw forces the trees either to enter the tree gate to the saw opening or pushes them fully out of the saw's path. The saw blade is flame-cut, 64 inches in diameter, 3/4 inch thick, and rotates at 800 revolutions per minute. Power is supplied to the saw by a hydraulic motor. The saw frame may be hydraulically raised or lowered to control stump height and avoid obstacles.

Once a tree has been cut, its butt is knocked forward by a trip chain mounted behind the saw. Simultaneously, a rotating persuader or "bat" strikes the tree 11 feet up its trunk, clearing the tree's top from the stand and directing it back into the tree basket. When 1 to 2 cords of trees have been collected in the basket, the bunch is dumped to the side away from the stand, clear of the machine's path in subsequent passes.

The machine with the skidder is 60 feet long, weighs 136,700 lb loaded, and has a loaded footprint pressure of 12 psi under the trailer tires. Power for the swather's hydraulic functions is furnished by a 245-hp engine mounted on the trailer. During harvesting, the machine travels at speeds up to 3 mi/h.

The tree harvester should reduce the cost of harvesting small-diameter material for stand treatment. The tree harvester is limited to slopes under 20 percent, but there are many thousands of acres of stagnant stands located on terrain with suitable slopes. Combined with the chunkwood chipper technology, the "swather-chunker" system can efficiently convert small stems into a product suited to fuel or fiber end uses.

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Products, Processes, and Markets

Chaired by: Charles H. Hawkins III

Small lodgepole pine trees have historically found limited markets for posts, poles, rails, and similar products. Volumes of material utilized by these markets today are very small in comparison to the total available resource, although the growth potential in such markets has not been exhaustively explored. An essential key to more extensive management of the small lodgepole pine resource is the identification of new product markets, especially for products or uses that are relatively high-valued. Lodgepole pine has a number of favorable physical characteristics that make it particularly well suited to both roundwood and chip, flake, or fiber products. Information presented in this section discusses product prediction, the current post and pole industry in Montana, and the outlook for other uses.

PREDICTING PRODUCT POTENTIAL IN SMALL-STEM LODGEPOLE PINE STANDS

Charles H. Hawkins III and Joyce A. Schlieter

ABSTRACT: Managers need a procedure to assess product potential in small-stem stands using conventional stand table or cruise plot information. A system that predicts merchantable length and potential product recovery using diameter at breast height (d.b.h.) and total height for lodgepole pine trees in 3- through 7-inch d.b.h. classes is briefly described. Results of the research include tabled alternative product mix information for representative small-stem lodgepole pine stands, as well as a general computer routine. Users have the options of applying the product information developed for a sample stand that has characteristics similar to the stand they are evaluating, or using the computer routine with stand table or cruise plot data to identify product potential. This paper includes only the tabular results for a single sample stand.

BACKGROUND AND OBJECTIVES

Forest managers in the Rocky Mountain West are faced with a major problem: How can effective multiple-resource management be achieved in stands of small-stem, economically submarginal lodgepole pine? Harvesting merchantable forest products is generally the principal means available to finance work on desired silvicultural and nontimber resource objectives. Consequently, an important management function is to identify merchandising opportunities, alternatives, and values. Specific knowledge of the kinds, quantities, and values of merchantable products that can be recovered from a stand will enhance the management planning process.

Actual product recovery from similar stands is obviously of interest. But such operations may be false indicators of real product potential, because individual operators are strongly influenced by personal preference, equipment limitations, and market constraints. What forest managers need is an effective methodology for predicting total product potential in small-stem stands using conventional stand table or cruise plot information. Also important is the identification of alternative product mixes or combinations and associated values recoverable from a stand.

To satisfy this need, we developed a system that enables managers to accurately predict potential of a stand to produce various combinations of common small-diameter roundwood products. Estimates of the gross product potential are reduced to realistic net estimates based on observed tree defects in the stand.

We hope this methodology will be useful to both land managers and harvesting operators in evaluating economic feasibility. Although many small-stem stands may not generate a profit under any circumstance, the ability to identify product potential and maximize value recovery will tend to reduce the net costs of desired stand treatments.

This paper provides only a capsule description of the methods developed, along with tabled product potential information for one sample lodgepole pine stand. A comprehensive version including tabular results for nine representative small-stem lodgepole pine stands and a general purpose computer routine will be published by the Intermountain Research Station as a General Technical Report.

We defined four major objectives that needed to be met to provide maximum flexibility in a product prediction process for small lodgepole pine:

1. Develop a method for estimating gross product potential for a stand from a stand table. This method requires only the availability of a stand table for the timber being examined, and uses average total tree height in each diameter class.
2. Develop a method for estimating gross product potential for a stand from individual tree data, where detailed cruise plot records are available describing individual sample trees.
3. Develop a method for reducing gross product potential to net potential, for stands that have individual tree defect data available.
4. Apply gross and net product prediction methods based on individual tree records (items 2 and 3) to nine selected sample stands representing a broad range of tree size and stand density. Describe these stands sufficiently to allow direct comparison with stands of interest to managers.

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Charles H. Hawkins is owner and principal consultant, Rocky Mountain Forestry, White Sulphur Springs, MT. Joyce A. Schlieter is Mathematical Statistician, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT.

The study approach defined by these objectives was purposely chosen to accommodate a wide range of stand information availability. Information available to the manager may vary from detailed individual tree cruise data to aggregate stand table information, or perhaps only a general knowledge of the character of the stand. Objectives 1, 2, and 3 are directed toward providing methods that can effectively use individual tree or stand table information, while objective 4 is concerned with providing actual product information for sample stands that may then be compared to stands of interest.

PREDICTION SYSTEM DEVELOPMENT

Prediction system development made use of stand and tree data accumulated from 19 sample lodgepole pine stands geographically dispersed from the Wasatch-Cache National Forest (Utah-Wyoming) to the Lewis and Clark National Forest (north-central Montana). All stands were essentially pure lodgepole pine, ranging in stand density from 1 to 7 thousand green stems per acre, and in diameter from 7 inches d.b.h. down. They are broadly representative of the extensive overstocked, small-stem lodgepole pine stands occupying several million acres in the inland West.

The Stem Profile Table

The number and kind of roundwood products that can be obtained from a tree are determined by the profile of the stem--butt diameter, rate of taper and upper stem diameters, and length to some minimum useable diameter. As a basis for

Table 1--Stem profile table for lodgepole pine, indicating length to specified top diameters, by total height and diameter at breast height (d.b.h.) classes

Total height	Top diameter[1]	Diameter at breast height (inches)				
		3	4	5	6	7
Feet	Inches	Feet				
25	3	4	10			
	2	15	18			
30	4		4	10		
	3	4	13	18		
	2	19	22	24		
35	5			4	11	
	4		4	13	20	
	3	4	17	22	27	
	2	23	26	28	31	
40	5			4	14	22
	4		4	16	23	29
	3	4	21	26	30	35
	2	27	30	33	35	38
45	5			4	16	25
	4		4	19	26	32
	3	4	25	29	34	39
	2	31	34	37	39	42
50	5			4	19	27
	4		4	24	29	36
	3	4	28	33	38	42
	2	36	38	41	43	46
55	5			4	21	30
	4		4	26	32	39
	3		32	37	41	46
	2		42	45	48	50
60	5					32
	4					42
	3					50
	2					54

[1]Regression equations used (for top diameters less than d.b.h.):

Top diam.	Predicted length	R^2	se
2	-13.685 + 2.64(d.b.h.) + 0.826(hgt)	0.92	2.35
3	-27.687 + 4.698(d.b.h.) + 0.744(hgt)	.87	3.14
4	-40.979 + 6.51(d.b.h.) + 0.619(hgt)	.85	3.31
5	-56.613 + 8.233(d.b.h.) + 0.522(hgt)	.71	3.86

assessing product potential, we first developed a table of stem profiles that represented the range of tree diameter and height classes encountered on study sites.

An initial question to be resolved was whether tree d.b.h. and total height alone were capable of adequately explaining variation in "merchantable" stem length to various top diameters. We analyzed tree dimension data from the Montana and Utah/Wyoming sites separately, using stepwise regression methods to examine a number of independent variables, including tree d.b.h., total height, stand density, age, and site index. The analyses indicated that d.b.h. and total height were the only variables needed to predict stem length to specified top diameters. Density, age, and site effects are adequately reflected in the diameter-height relationship, and do not have to be accounted for separately. Any one stem d.b.h./height class can therefore be represented by a single stem profile, regardless of stand location or characteristics. Data from the Montana and Utah/Wyoming sites, totaling 341 destructively sampled trees, were consequently pooled to develop regressions predicting stem length to specified top diameters, for lodgepole pine trees from 3 to 7 inches d.b.h.

The next step was validation. A second sample of 103 trees was selected from seven of the study stands to cover the range of each d.b.h. class of interest. For example, in the 3-inch class one tree was chosen in each stand with d.b.h. between 2.6 and 2.8 inches, one with d.b.h. between 2.9 and 3.2, and one with d.b.h. between 3.3 and 3.5. The selected sample trees were felled and diameters were recorded at various heights up the stem. Comparisons of measured profiles for these sample trees with predicted profiles from the original stem length regression equations showed a high correlation.

The final step was to combine the original sample (341 trees) with the validation sample (103 trees) and recalculate stem length regression equations. Table 1 shows the resulting predicted stem length to specified top diameters for various d.b.h. and total height combinations. The regressions and tabled values are based on the total sample of 444 felled and measured trees from all 19 sample stands. The stem profiles described by the regressions and table should be representative of all lodgepole pine trees in the diameter and height classes shown.

Product Specifications and Values

Our intent was to develop a procedure that would predict product potential in terms of some common small-diameter products currently utilized by operators in the northern and central Rocky Mountain area. The product specification search revealed a large number of roundwood products with length and diameter requirements varying among manufacturers--and virtually no industry standardization. For example, one post and pole yard makes 37 different post products in addition to a variety of pole and sawed products.

A few products, however, are relatively standardized and represent the range of products and values the average operator might recover. Table 2 lists seven such products with lengths, minimum and maximum small-end diameters, and values per piece as well as per cubic foot. Values are an amalgamation of prices paid for raw material delivered to manufacturing points early in 1984.

Alternative Product Mixes

Using the stem profile table and the seven specified roundwood products, we developed a system to generate a matrix of all possible gross product alternatives for a tree of specified d.b.h. and height. This may be the average tree in a d.b.h./height class if a stand table is being used as input data, or the d.b.h. and height class of individual sample trees if individual tree records are used. Based on observations of the physical characteristics of small-stem lodgepole pine, certain standard operating rules were established. These constraints included taking 1 foot off the butt end of the tree to avoid butt swell, requiring that props and panel poles come only from the 3- and 4-inch d.b.h. classes (avoiding limby tops), and searching for barn poles only in the 7-inch d.b.h. class. We further specified a minimum "merchantable" top

Table 2--Product specifications and values for selected roundwood products commonly recovered from lodgepole pine

Product	Length	Small-end diameter		1984 value[1]	
		Min.	Max.	Piece	Ft^3
	Feet	--------Inches--------		-------Dollars--------	
Post	7	4	7	0.52	0.54
Rail	13	3	5	.65	.49
Rail	17	3	5	1.24	.67
Rail	21	3	5	1.45	.59
Prop	10	2.25	4	.50	.83
Panel pole	17	2	2.5	.50	.86
Barn pole	17	6	7	2.38	.62

[1]Prices paid for raw material f.o.b. manufacturing points.

diameter, above which products would not be recovered, for each d.b.h. class:

D.b.h. class	Minimum top diameter
3 and 4	2 inches
5 and 6	3 inches
7	4 inches

Table 3 gives alternative product mixes, residual stem volumes, and tree values for a range of total height classes within the 4-inch d.b.h. class. Residual volume is the unutilized cubic foot volume to the defined minimum top diameter. Similar tables were developed for the 3-, 5-, 6-, and 7-inch d.b.h. classes.

The matrix of alternatives for a particular diameter/height class can be used to pick the product combination that will maximize value. Or, an alternative with desired products can be selected. In the applications shown here, the alternative to maximize value has been used.

Approach to Defect

The estimation of gross product potential ignores the possible presence of defect in trees. If limiting or inadmissible defects are present in the stem or stand, actual product recovery will obviously be reduced. As part of this study, we examined alternatives for using individual tree defect data to adjust gross to net product potential.

Based on experience with local operators and a survey of manufacturing operations, we defined seven types of defect that influence product recovery. These were crook, fork, fire scar, catface, knot-cluster, mistletoe or canker swell, and sweep. We also developed criteria to assess the effects of defect occurrence on product potential.

Defect analysis was made using individual tree data collected from 1,817 sample trees on nine of the study sites. Table 4 gives a summary of the

Table 3--Alternative product mixes and values for the 4-inch d.b.h. class of lodgepole pine

Hgt.	Alt.	7-ft post	13-ft rail	17-ft rail	21-ft rail	10-ft prop	Panel pole	Residual volume	Value
								Ft^3	Dollars
25	1	0	0	0	0	1	0	0.23	0.50
30	1	0	0	0	0	1	0	.42	.50
	2	0	0	0	0	0	1	.32	.50
35	1	0	1	0	0	0	0	.46	.65
	2	0	0	0	0	2	0	.14	1.00
	3	0	0	0	0	0	1	.62	.50
40	1	0	1	0	0	1	0	.18	1.15
	2	0	0	1	0	0	0	.46	1.24
	3	0	0	0	0	2	0	.32	1.00
	4	0	0	0	0	1	1	.05	1.00
45	1	0	0	0	1	0	0	.45	1.45
	2	0	0	0	0	3	0	.08	1.50
	3	0	1	0	0	0	1	.08	1.15
	4	0	1	0	0	1	0	.36	1.15
	5	0	0	1	0	1	0	.18	1.74
	6	0	0	0	0	1	1	.49	1.00
50	1	0	0	0	0	3	0	.22	1.50
	2	0	0	0	0	2	1	.00	1.50
	3	0	0	1	0	0	1	.08	1.74
	4	0	1	0	0	0	1	.57	1.15
	5	0	2	0	0	0	0	.40	1.30
	6	0	0	0	1	1	0	.18	1.95
	7	0	0	1	0	1	0	.35	1.74
	8	0	1	0	0	2	0	.11	1.65
55	1	0	0	0	0	3	0	.40	1.50
	2	0	0	0	0	2	1	.11	1.50
	3	0	0	0	1	0	1	.08	1.95
	4	0	0	1	0	0	1	.58	1.74
	5	0	1	0	0	1	1	.02	1.65
	6	0	2	0	0	1	0	.14	1.80
	7	0	1	1	0	0	0	.40	1.89
	8	0	1	0	0	2	0	.26	1.65
	9	0	0	0	1	1	0	.35	1.95
	10	0	0	1	0	2	0	.11	2.24

Table 4--Summary of defect occurrence for the Corduroy Creek East sample stand

D.b.h. class	Number of defects			Locatable[1] defects by quarter[2]				Sweep
	0	1	2+	1	2	3	4	
Inches	Percent of stems							
3	18	27	55	76	36	22	31	0
4	24	27	49	57	19	27	38	0
5	32	42	26	58	26	10	16	0
6	14	57	29	50	57	7	21	0
7	100	0	0	0	0	0	0	0

[1]Locatable defects recorded included crook, fork, fire scar, catface, knot-cluster, and swell.

[2]Quarter segments are defined as quarters of merchantable stem length (1 = 0 - 25 percent).

defect occurrence found in one of the nine sample stands. The percentage of stems with 0, 1, or 2+ defects is shown by d.b.h. class. Also, the percentage of stems with defects located within each quarter of the merchantable stem length is reported by d.b.h. class. The exact location of each defect in the stem was recorded, as well as the length of stem affected by the defect. These defective lengths were then deducted from the stem and the remaining stem was searched for products.

Adjustment of potential product recovery to account for defect requires either individual tree defect information, as was collected for these nine stands, or a "defect factor" based on general experience. To adjust both the product mix recoverable and the value requires individual tree data. A "defect factor" can be applied only as an adjustment to total recovery and value.

APPLICATIONS OF THE METHOD

Managers have three alternatives for predicting product potential, depending upon the stand information available. Individual sample tree cruise data allow direct estimation of gross product potential, tree by tree, as well as reduction to net potential if tree defect information also exists. If information is limited to an aggregate stand table, gross product potential can be estimated using it alone. And if neither sample tree cruise data nor stand table data exist, a manager can simply use the gross and net product potential information developed for a sample stand that most nearly matches the stand of interest.

Gross Product Potential From a Stand Table

To estimate the gross product potential from a stand table, a measure of the average total height of trees in each d.b.h. class is needed. This allows the appropriate alternative product combination to be chosen for each diameter class. The number of products in chosen alternatives are then multiplied by stems per acre to give predicted gross products per acre. Table 5 is a stand table for one of the sample stands. For this stand table, the product combinations that maximize value are shown in table 6.

Table 5--Stand table for the Corduroy Creek East sample stand[1]

D.b.h. class	Average height	Stems/ acre	Volume/ acre
Inches	Feet	Number	Ft^3
3	40.1	750	810
4	46.1	617	1,339
5	50.7	317	1,160
6	54.5	233	1,300
7	57.7	33	262

[1]Based on inventory of all stems of 3-inch d.b.h. and larger on six 1/100-acre plots.

Gross and Net Product Potential From Individual Tree Data

Individual tree cruise data that include defect information provide the most reliable basis for product prediction. To demonstrate the use of individual tree data, we chose nine of the sample stands that represented a spectrum of typical stand conditions in small-stem lodgepole pine. Six to nine 1/100-acre plots were established in control units for each of these stands. Defect was identified and measured in all trees with at least a 3-inch d.b.h. Individual tree data were used to estimate gross and net product potential. The matrix of alternatives was used to obtain gross product potential with the assumption that each sample tree was free of defect. The information used was d.b.h. and total height. For the net product potential, trees were searched for products after all defective portions were eliminated.

Table 6--Gross product estimates per acre for the Corduroy Creek East sample unit, using the stand table as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	--------------	------	------	Number	------	------	------	Ft³	Dollars
3						750		172.50	375.00
4			617		617			111.06	1,073.58
5	634		317					15.85	722.76
6	699		233					25.63	652.40
7	33		33				33	0	136.62
Total									2,960.36

[1]Products: 1 = 7-ft post; 2 = 13-ft rail; 3 = 17-ft rail; 4 = 21-ft rail; 5 = 10-ft prop; 6 = 17-ft panel pole; 7 = 17-ft barn pole

Table 7--Gross and net product estimates per acre for the Corduroy Creek East sample unit, using individual tree records as a basis for prediction

D.b.h. class	Products[1] 1	2	3	4	5	6	7	Residual volume	Value
Inches	--------------	------	------	Number	------	------	------	Ft³	Dollars
3 Gross					217	567		75.33	391.67
Net					167	250		292.50	208.67
4 Gross			433	83	467	33		162.50	908.17
Net		50	200		467	67		394.67	547.50
5 Gross	617		200	117				15.83	737.83
Net	467	17	217	66				177.00	618.74
6 Gross	650		200	33				25.67	634.33
Net	550	17	150	50				219.17	555.96
7 Gross	67		17				33	0	134.67
Net	67		17				33	0	134.67
Total Gross									2,806.67
Net									2,065.54
Reduction in total value due to defect									26.4 percent

[1]Products: 1 = 7-ft post; 2 = 13-ft rail; 3 = 17-ft rail; 4 = 21-ft rail; 5 = 10-ft prop; 6 = 17-ft panel pole; 7 = 17-ft barn pole

Table 7 shows the gross and net product estimates from individual tree records for one of the nine sample stands. This table also gives the unutilized volume to the minimum top diameter, the value for each d.b.h. class, and total stand value. The reduction in predicted total stand value due to defect was 26 percent. Product mixes changed in a few cases, and net residual (unused) volume is greater than gross residual volume. As expected, net value is less than gross value except in the 7-inch d.b.h. class, which had no defect. Figure 1 illustrates the gross and net values and shows that the greatest reductions due to defect were in the 3- and 4-inch d.b.h. classes.

Product Potential by Comparing Stands

The nine stands for which gross and net product potential have been calculated, based on individual tree data, represent a wide range of

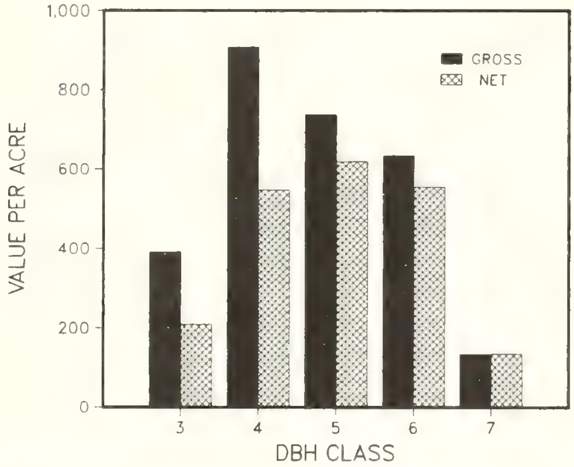

Figure 1--Comparison of gross and net values for the Corduroy Creek East sample unit.

stand conditions. In the absence of specific stand table or cruise data, or as a matter of expediency, a manager can simply use product information for one of these stands that most nearly matches a stand of interest. Important stand comparison criteria are size class distribution of stems, stand density, and defect occurrence. If a stand is similar in these respects to one of the nine stands analyzed, the product potential should also be similar.

Managers may also have stand information--a stand table, for example--that allows estimation of gross product potential, but no information describing defect in the stand. Comparison with one of the nine sample stands provides a way of choosing a "defect factor" or value reduction factor that can be used to adjust gross product potential.

ADDITIONAL INFORMATION

A major output of our study is a complete set of tables of alternative gross product mixes, such as table 3 illustrates, derived from the stem profiles for the defined group of products. The tables, covering lodgepole pine trees of various total heights in the 3- to 7-inch d.b.h. classes, will be contained in an Intermountain Research Station General Technical Report now being prepared. The report will include a general computer routine to generate similar tables for other user-specified products.

Also included in the report will be gross and net product potential information for the nine stands selected for complete analysis. Basic stand table and defect information for each stand will provide a way to compare other stands to these.

AN ECONOMIC ANALYSIS OF PRODUCTION AND MARKETS: THE POST AND POLE SECTOR IN MONTANA

David H. Jackson and Kathleen O. Jackson

ABSTRACT: The post and pole sector of the wood products industry is a principal purchaser of small-diameter lodgepole pine material. A study was conducted to develop a better understanding of production processes, marketing, and distribution channels, and raw material demand and acquisition characterizing post and pole firms in Montana. This report is a brief summary of the full study report, which will be published separately.

INTRODUCTION

Small-diameter lodgepole pine timber historically has been a favored raw material in the post and pole sector of the wood products industry. Current interest in improving the management (and therefore, utilization) of extensive areas of small-diameter lodgepole pine has focused attention on such markets. Although considerable time and effort have been spent studying the lumber, plywood, and pulp and paper industries, much less is known about the post and pole business. Aside from a basic census of Montana's wood manufacturers, very little is known about post and pole production as a separate sector.

THE STUDY

The purpose of this study was to improve the descriptive and analytic level of information about Montana's post and pole industry. Specific objectives included characterizing the nature of the firms; describing products and product values; describing markets and distribution channels; identifying sources of raw material; and evaluating raw material demand and supply characteristics. Data were collected by interview with post and pole firms. The survey included 24 known producers in 1985, of which 88 percent provided the requested information.

Summary of a paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986. The full report by the authors is on file at the Forestry Sciences Laboratory, Intermountain Research Station, Missoula, MT. This brief summary was abstracted from the full report by Robert E. Benson, Research Forester, Intermountain Research Station.

David H. Jackson is Professor and Kathleen O. Jackson is Faculty Affiliate, University of Montana, Missoula, MT.

STUDY RESULTS SUMMARIZED

Results of the study include information portraying firms in the industry; characteristics of production, marketing, and distribution; and an evaluation of factors influencing raw material pricing. Raw material demand and price elasticity of demand are also examined, with implications for increased utilization.

Nature of Firms--Firms range from part-time, one-employee operations to plants with more than 20 annual employees. The average firm has the equivalent of seven year-long employees, counting full- and part-time employees. Payrolls average about \$90,000 per year, ranging from about \$6,000 to \$500,000. About half the firms have capital (replacement) values of less than \$10,000, and about half more than this amount.

Products--Firms in Montana marketed about 3 million cubic feet of products in 1985, with posts accounting for 56 percent. Poles and rails were the other major products. Based on product output, the industry in Montana is somewhat concentrated, with the four largest firms accounting for two-thirds of the output.

Markets and Distribution--About 43 percent of the products were shipped within Montana in 1985; 20 percent were shipped to California/Nevada, 13 percent to Colorado/Wyoming, and 13 percent to Nebraska/Dakotas. About 44 percent went to wholesalers, 21 percent to retailers, and 35 percent directly to end users. Agribusiness and its economic health is considered the most important market factor influencing producers' market potential. Highway and public works projects are also important contributors to market volume.

Freight rates and plant locations, both related to shipping costs, were also important factors. Larger firms marketed more outside the State than did smaller firms, and also used wholesalers more.

Raw Materials--Sources of raw materials for Montana plants were:

Source	Percent
National Forests	35.4
Private forest land	31.2
State forests	4.1
Other	29.3
Total	100.0

The most frequently cited problem in obtaining raw material was difficulty in finding woodcutters. Constraints on availability of timber and "red tape" in purchasing were also considered important factors adversely influencing acquisition.

Prices and Value Added--Products and purchaser's specifications for raw materials vary widely. To develop a basis for analyzing prices, three price equations were developed for short (5 ft to 10 ft), midlength (10 ft to 18 ft) and long (18 ft to 30+ ft) raw material. Similar equations were developed for products (posts, rails, poles) using additional processing variables such as peeling, treating, and pointing. From these equations, raw material price and product values can be calculated and used to estimate value added. For example, for a 6.5-ft post, 4-inch top, treated, the predicted values are:

Item	Value
Product selling price	$1.80
Material purchase price	.47
Value added	$1.33

The equations can be used to develop values on either a per-piece or per-cubic-foot basis.

Demand and Supply Schedules--In addition to the profile of the industry, the study developed estimates of the demand schedule for raw material and the supply schedule for products. Two approaches were used. A conventional production-function approach based on observed relationships between amounts of capital, labor, and raw materials indicated that no scale economies exist over the range of industry capacity observed. Marginal costs of labor and capital are constant, and therefore, the derived demand function is perfectly elastic. In such a situation, quantities of raw material demanded and products produced are infinitely sensitive to price (but in practice, are purchased or sold at only one price--the prevailing market price).

An alternative "willingness to pay" approach was also used. Producers were asked what would happen if raw material prices or product prices were to change. Based on the responses, the price elasticity of demand for raw materials was estimated to be -1.52; that is, raising the costs of raw material by 1 percent would decrease the amount of raw material demand by 1.52 percent. Regarding product output, it was estimated that the price elasticity of supply of post and pole products offered is +1.97; that is, a 1 percent increase in product prices would increase the amount offered by producers by 1.97 percent.

The results indicate rather strongly that demand for raw material and products are price-elastic. Price changes would result in more than proportional changes in quantities of raw material purchased and products produced.

CONCLUSIONS

Five general conclusions were drawn regarding the Montana post and pole industry:

1. The industry is limited by markets, not by raw material supply or other production factors.

2. The economic health of agribusiness is the most important factor affecting market size.

3. National Forests are an important, but not dominant, supplier of raw material to the industry.

4. Demand for raw material is price-elastic; for a given percent increase in material costs, the amount demanded by post and pole producers will decrease by a greater percentage.

5. Supply of finished products is also price-elastic; for a given percent increase in product prices, producers would increase the amount offered by a greater percentage.

A SITE-SPECIFIC ASSESSMENT OF POTENTIAL WOOD RESIDUE USES IN NORTHWESTERN MONTANA

Charles E. Keegan III

ABSTRACT: An estimated 100,000 to 150,000 dry tons of mill residue suitable for fuel should be available annually to a new user in northwestern Montana. Whole-tree recovery systems can provide the lowest cost forest residue for use as fuel. Small timber would also be available as residue from timber stand improvement projects. Uses of wood as a substitute for coal, or to generate electricity, generally could not support recovery of small timber. Wood as a substitute for fuel oil and natural gas could in some cases support the cost of harvesting small timber.

INTRODUCTION

In this paper I will discuss results of a site-specific assessment of wood residue utilization opportunities in northwestern Montana--specifically the area surrounding Libby, MT. The project was a cooperative research effort between the Bureau of Business and Economic Research at the University of Montana and the Intermountain Research Station of the Forest Service, U.S. Department of Agriculture. Ron Barger of the Forestry Sciences Laboratory in Missoula was the major Forest Service participant. The results will be reported in detail in "Utilizing Wood Residue for Energy in Northwestern Montana: An Assessment of Feasibility" (Keegan and others), a General Technical Report currently in preparation at the Intermountain Research Station.

Here I will:

1. Briefly describe the project and some of the project's results focusing on what components of wood residue offer the best opportunity to supply additional increments of wood fiber for utilization.

2. Examine what various users, especially energy users, might be able to pay for wood fiber.

3. Relate this to estimated costs of harvesting and delivering small timber.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Charles E. Keegan III is Associate Director of the Bureau of Business and Economic Research at the University of Montana, Missoula, MT 59812.

The project had two major goals: (1) development of methodology that would be applicable throughout the Intermountain and Pacific Northwest regions in other site-specific assessments, and (2) an actual assessment of feasibility of increased wood residue utilization in the northwestern Montana area with an emphasis on the use of residue for energy.

The project resulted in five major types of information:

1. The methodology.

2. A wood residue supply schedule, which indicates estimated volumes of particular components of the wood residue resource available for different cost levels.

3. An assessment of regional demand for low-value wood fiber based primarily on current and planned capacity for reconstituted product uses and industrial fuel use. We also examined what users might be able to pay in competition with each other.

4. A financial analysis of various wood-fired facilities to generate electricity and analyses of the use of wood as a substitute for natural gas, fuel oil, and coal.

5. An identification and evaluation of additional constraints and benefits to increased wood residue utilization.

COMPONENTS OF THE RESIDUE RESOURCE

We fit wood fiber residue first into two major categories: mill residue and forest residue. Mill residue is generated in the manufacture of lumber, plywood, and other primary wood products. In the Inland Northwest, residue from lumber and plywood plants accounts for virtually all of this type of residue, and this is where the analysis was concentrated.

The second major category--forest residue--we defined broadly as any unutilized or underutilized component of the available timber resource.

MILL RESIDUE AVAILABILITY

In years of average or higher lumber and plywood production our projections indicate a surplus of mill residue suitable for fuel. It should be

mostly bark and sawdust. Although this surplus is a large problem for individual mills and represents a serious disposal problem, it is small relative to the total supply of mill residue and small relative to current demand. Total supply also varies directly as lumber production varies. Therefore, the surplus could disappear in the short term with a recession in the lumber industry or in the long term due to changes in total sawmill capacity or demand.

Currently, I believe users in northwestern Montana or northern Idaho could secure through long-term contracts 150,000 dry tons annually (12 million ft^3) at a delivered cost of $10 to $30 per dry ton. This would be about 120,000 cunits (a cunit is 100 ft^3 of solid wood) at an estimated cost of $12.50 to $37.50 per cunit. Again, this material would be mostly in the form of bark and sawdust. Lesser amounts would be available in other parts of the State.

FOREST RESIDUE AVAILABILITY

Forest residue includes a wide array of material. We dealt with it in the following categories:

1. Logging residue--unutilized material that would be available in conjunction with sawtimber harvest operations.

2. Timber stand improvement residue--residue from thinning and stand conversion operations. Thinning residue is material cut and generally left at the operation site. Stand conversion residue is cut to convert stagnant, improperly stocked stands to younger, properly stocked stands.

3. Untreated slash from previous logging operations.

4. A catch-all category--all other material not included in other categories and not part of sawtimber or sawtimber growing stock. Generally this is material at sites not scheduled for harvest or other treatments.

We were fortunate to undertake our project at the same time that the Pacific Northwest Research Station of the Forest Service was cooperating with the Intermountain Research Station on an inventory of recently logged-over lands in Montana. The results indicated that although relatively large volumes of wood fiber are currently left at logging sites, virtually all of it is in pieces too small to consider recovering in its present state. What is commonly thought of as logging slash, large dead and cull green logs, does not exist in large quantities in Montana.

What then is available? Our conclusion was that the best opportunity to utilize forest residue for fuel would be to recover through whole-tree logging systems the tops and limbs of sawtimber trees or pulpwood trees being harvested to recover products from the bole. Theoretically, this is low-cost wood fiber, although this has not been verified through field trials in Montana. Our estimates of cost were $20 to $50 per ovendry ton or $25 to $65 per cunit.

The only other component we felt would offer opportunities to a large-volume user would be small timber available in timber stand improvement projects. This--especially small-diameter lodgepole pine--of course, is also material suitable for some specific roundwood product uses. Costs of recovering this material vary tremendously. However, by choosing the most favorable harvest opportunities in 4- to 8-inch-diameter timber, our estimates indicate a user could recover moderate volumes for $30 to $50 per ovendry ton or an estimated $40 to $65 per cunit.

SMALL TIMBER FOR ENERGY AND PRODUCT USES

Small timber has different values for various uses and this value relates to the recovery cost of the timber. I will use the term "value use range" to mean an estimate of what plants or facilities of various types might pay for delivered wood and still operate profitably.

Figure 1 depicts the value use range of timber delivered for various uses. Value use is depicted by the solid bars across the face of the graph. The uses are identified in groups comprised of energy uses, reconstituted products, and solid products. The energy uses include wood used to generate electricity and as a replacement fuel for coal, natural gas, and fuel oil. The reconstituted products uses are particleboard, fiberboard, waferboard, and pulp and paper manufacturing. The solid products are posts and rails, studs, and houselogs.

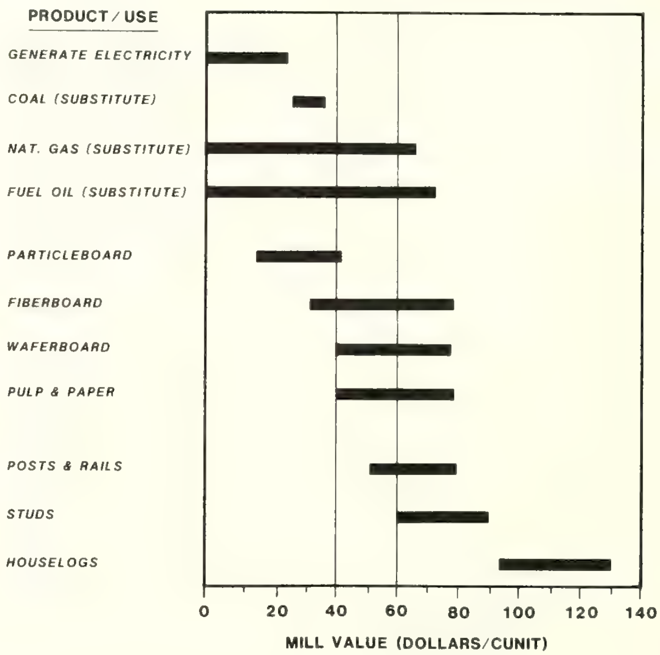

Figure 1--Estimated value use of wood fiber for energy and selected products in the Inland Empire Region (1984 dollars). Bureau of Business and Economic Research, University of Montana, Missoula, MT.

The two vertical lines represent what I have called a realistic, but somewhat optimistic, estimate of the cost to harvest and deliver small timber in relatively large quantities--in excess of 1 million ft^3 per year delivered to a single facility through recovery of thinning and other timber stand improvement residue. The estimates are $40 to $60 per cunit or $30 to $45 per oven-dry ton.

As figure 1 indicates, energy uses generally rank below product uses. Generating electricity was identified as a very low value use for wood. I think there is virtually no opportunity for a private sector investor using conventional sources of capital to harvest timber--small or large--and generate electricity profitably in Montana.

There also appears to be little, if any, opportunity to substitute wood for coal. Little coal is used in the timber-producing regions of the State, and proposed wood-fired projects have not developed partly because of the low cost of coal in other areas. The use of wood as a substitute for natural gas and fuel oil had the highest potential for energy use. At prices of $65 and $70 per cunit, small timber could certainly be harvested. The opportunities to utilize small timber as a substitute fuel may not look as good as the $65 or $70 per cunit maximum value indicated, however. First, note the large size of the ranges 0 to $70 and 0 to $65. This is because of large variability in capital costs of the systems and capacity utilization of heating systems. Primarily because of this variability, use of wood as a substitute for natural gas or fuel oil must be evaluated on a case-by-case basis.

Two additional factors also impact the use of wood in place of these fuels. Currently, natural gas and fuel oil prices are lower than those used in our analysis, and substantial increases are not projected for the near term. In addition, a new rate structure allows power companies in Montana to offer low natural gas rates to users with opportunities to switch to other fuels.

OUTLOOK FOR USING SMALL TIMBER FOR ENERGY

I would expect no large-scale use of small-diameter timber for energy in the next 5 years. Generating electricity, which could be a very high volume user of wood fiber, would require much higher electrical rates than are currently in effect before small timber could be used. Further new power would be based first on sources such as coal, hydro, and cogeneration using mill residue (and perhaps logging residue in the form of tops and limbs of sawtimber trees). These would all be cheaper than power based on harvesting small timber.

Some nearer term opportunities may exist for industrial and institutional users to shift from fuel oil and natural gas to wood. The lower cost of fuel oil and natural gas and a new rate structure do not make the use of harvested timber impossible, but certainly less attractive than a year ago. The key will be what happens to oil and natural gas prices. I believe in the long term, the role of wood for energy in Montana--which is already important--will expand. But looking at small-diameter timber and lodgepole pine in particular, I do not foresee any developments on the immediate horizon that will support a level of utilization sufficient to solve some of the very large management problems that exist.

UTILIZATION OF LODGEPOLE PINE--
IDENTIFICATION OF THE PROBLEM AND A PROPOSED PARTIAL SOLUTION

Peter Koch

ABSTRACT: Lodgepole pine is dominant on about 13 million acres of commercial forest land in the United States; most of these acres are in the Rocky Mountains, and nearly half the volume in the Rockies is in Montana. Because of small diameters, most lodgepole pine offers little opportunity for profitable processing through conventional sawmills. The public land manager faces the problem of how to clearcut and regenerate large acreages of stagnated or otherwise unproductive stands of lodgepole pine without expending public funds to cover the direct costs, and to accomplish this stand replacement according to a management plan without jeopardizing the other values of the forest. Such stand replacement with vigorous new stands is done in contemplation of precommercial thinning to a prescribed stocking density when the new trees reach a height of about 15 to 20 feet. To partially solve the problem, an operation is proposed that would harvest (clearcut) 2,400 to 3,600 acres per year from stagnated lodgepole pine stands for delivery to a major center for segmenting whole trees into components to maximize tree value. Products would include conventional roundwood items (cabin logs, tree stakes, posts and poles), 2 by 4 studs, structural flakeboard, and fabricated joists employing flakeboard webs and minimally machined lodgepole pine stems as flanges.

INTRODUCTION

Lodgepole pine (Pinus contorta Dougl. ex Loud.) is the fourth most extensive timber type west of the Mississippi River and is dominant on about 13 million acres of commercial forest land in the United States. Most of these acres are in the Rocky Mountains, and nearly half the volume in the Rockies is in Montana.

In an attempt to improve utilization of lodgepole pine, a several-stage research effort was initiated in 1983. In the first stage, now completed, the world literature on the species was accumulated, keyworded, and appropriate data were entered to permit ready computer retrieval. Almost all the publications deal with forestry aspects--regeneration, protection, and growth and yield--only a miniscule fraction of the literature is concerned with utilization of lodgepole pine.

Next, the North American population of lodgepole pine (var. latifolia, and less intensively murrayana) was systematically sampled at 2.5° latitudinal intervals throughout the range of the species from 40 to 60° north latitude (fig. 1).

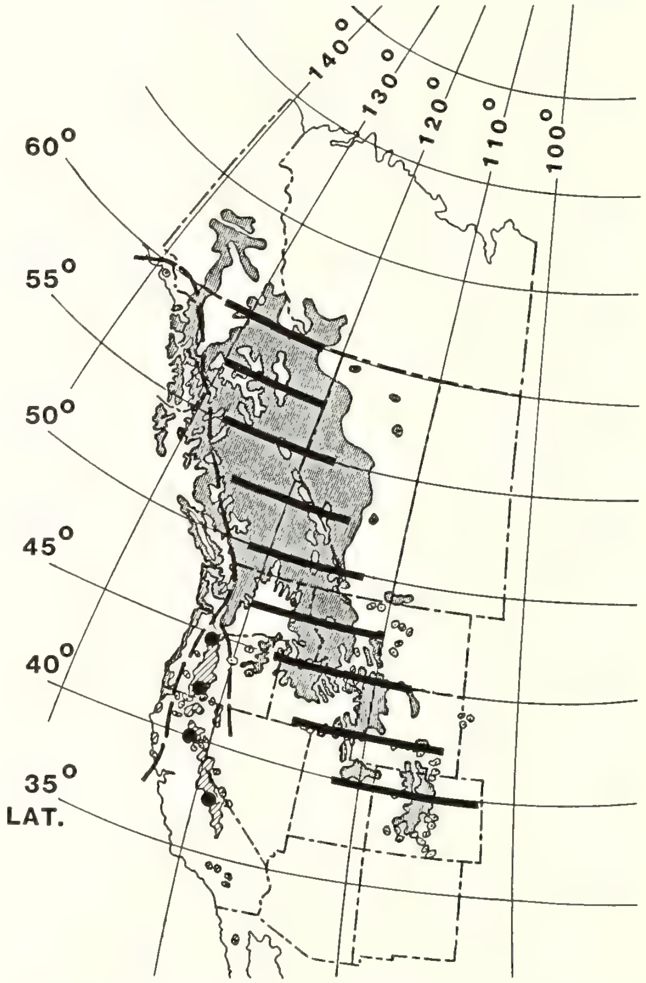

Figure 1--Sampling zones superimposed on Little's range map of lodgepole pine in North America. Variety latifolia is mapped to the right of the dashed lines, murrayana between them, and contorta to the left of them. Variety contorta was not studied because of its small potential for commercial use.

Results showed (Koch 1987) that properties of lodgepole pine vary significantly with latitude, elevation, and diameter class. For example, trees in Canadian latitudes have fewer open (nonserotinous) cones, higher specific gravity, more heartwood, less taper, and much lower moisture content than those in the United States.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Peter Koch is President of Wood Science Laboratory, Inc., Corvallis, MT 59828.

Trees from higher elevations within a latitudinal zone have more within-crown taper and thinner sapwood than those from lower elevations within the zone. Tree diameter class has a strong inverse correlation with stemwood specific gravity. Entire stemwood of trees 3 inches in diameter at breast height (d.b.h.) had average specific gravity (based on ovendry weight and green volume) of 0.43, 6-inch trees averaged 0.42, and 9-inch trees averaged 0.41. At stump height, trees 3, 6, and 9 inches in d.b.h. averaged 71, 91, and 107 years old, respectively.

In the third step, 28 representative public land acreages in the United States were identified (fig. 2) for which the responsible land managers seek intensified utilization. They range in size from 2,000 to 75,000 acres. During the summer of 1986, I visited each of these acreages to study the problem and to accumulate data preparatory to publication of an atlas (Koch and Barger in preparation) describing the areas. This 1986 work was done under a contract with the University of Montana; major funding was provided by the Intermountain Research Station, Forest Service, U.S. Department of Agriculture.

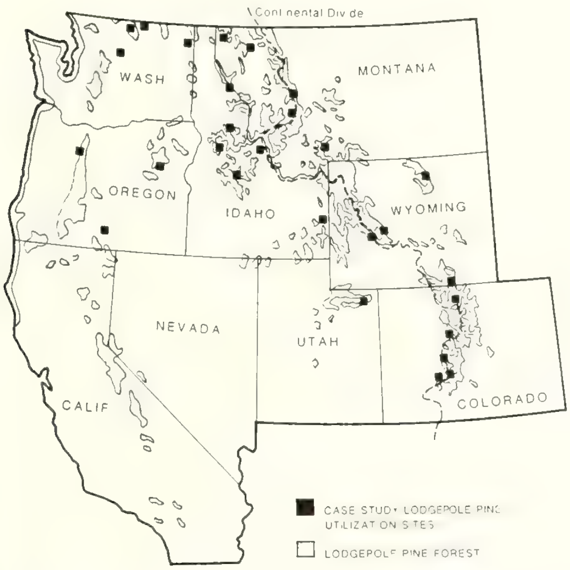

Figure 2--Locations (marked by black squares) of 28 representative acreages on public land in the United States for which the responsible land managers seek intensified utilization of lodgepole pine. The shaded area indicates extent of lodgepole pine forest type.

From these sequential operations, I have defined the problem as it appears to me, and arrived at a possible partial solution.

PROBLEM DEFINITION

The 28 acreages visited differ greatly. For example, although most are solidly forested in lodgepole pine, some contain significant amounts of larch, Douglas-fir, subalpine fir, spruce, or aspen. Meadows and grassy openings are common in the lodgepole pine acreages of Colorado, southern Idaho, and Wyoming. Growth potential varies from only slightly more than 20 cubic feet per acre per year to more than 100 cubic feet per acre per year. Annual precipitation varies from a low of slightly less than 20 inches to a maximum of near 40 inches. Terrain varies from nearly level to mostly steep; in aggregate, perhaps two-thirds of the lodgepole pine acreage delineated is on slopes of less than 45 percent. A few of the acreages are stony and strewn with boulders, but most are not excessively rocky.

Mortality--primarily from mountain pine beetle attacks--varies from most to virtually none of the stems. Defects in live trees that adversely affect utilization in solid wood products include porcupine scars (in some areas occurring on three-quarters of the stems and at several heights on each stem), stem crook, stem sweep, stem fork, cankers, fire scars, frost cracks, pith eccentricity, and excessive compression wood content, spiral grain, taper, and limbiness. Degree of defect varies greatly among and within acreages.

Accessibility of the acreages also varies significantly. Almost all have roads to their perimeters, and most have some interior roads; but a few can be reached only on foot. Most are within 50 miles of a railhead, but a few are more distant.

In virtually all of the acreages, stand type varies in a continuum. Classes of stands include "dog-hair" stands of trees less than 3 inches in d.b.h., pole stands with all trees live, pole stands with many dead trees, pole stands with dense understories of smaller trees, stands of sparsely stocked small sawtimber--usually over 200 years old, vigorous stands of large pole timber (6 or 7 inches in d.b.h.), stands of dead trees killed by bark beetles--many of suitable size for cabin logs--and stands of a variety of ages and generally low stocking containing relicts of past insect attacks as well as a range of smaller trees--usually suffering from mistletoe attack and cankers of various descriptions.

Most of the lodgepole cubic volume on the acreages visited is found in trees 3 to perhaps 6.5 inches in d.b.h.--trees too small to yield sawlogs. Trees are typically about 70 to 100 years old, with few stands less than 40 years old and some over 200 years old.

In the d.b.h. class from 3.5 to 4.0 inches, trees are generally about 35 feet tall, with few shorter than 22 feet and few taller than 55 feet; stemwood-average specific gravity of such trees ranges from 0.36 to 0.52, but is generally 0.40 to 0.44 (based on ovendry weight and green volume). For trees 3.5 to 4.0 inches in d.b.h., crown ratios are mostly in the range from 30 to 60 percent with the average slightly less than 50 percent. Below-crown stem taper (inside bark) is generally more than 0.4 and less than 0.8 inch per 100 inches, and averages about 0.6 inch.

Data from Montana lodgepole stands selected for 1985 thinning studies suggest that an average unthinned acre might contain 1,360 live stems 3 inches in d.b.h. and larger, totaling 3,400 cubic feet of stemwood, or about 43 tons of stemwood (ovendry basis). Considering all the 28 lodgepole pine stands I visited, however, it seems to me that a more conservative estimate for lodgepole in the Rocky Mountain area might be 1,000 live stems per acre measuring 3 inches in d.b.h. and larger, totaling 2,500 cubic feet of stemwood, or about 31 tons of stemwood, ovendry. When more accurate inventory data are available, even this lower estimate may prove too high.

On virtually all the acreages, post and pole operators nibble away at the pole stands, each cutting 1 to 3 acres annually near existing roads; such post and pole operations are sometimes used to achieve cosmetic thinning along these roads. These operators generally pay a stumpage fee of \$5 to \$7 per thousand lineal feet of product.

On Colorado and southern Wyoming acreages, some lodgepole pine Christmas trees are cut annually (stumpage fee of \$3 to \$5 per tree for personal use). Almost all acreages have a significant market for dead stems sold as firewood (usually \$2.50 to \$12.50 per cord stumpage fee). Firewood stumpage values frequently exceed sawlog stumpage values.

Occasionally, a sawlog sale of 15 to 500 acres is made, but virtually always at a stumpage cost less than that required to prepare the sale. Sawlog sales of more than 12,000 board feet per acre are unusual, and stumpage fees usually are in the \$6 to \$10 range with some sales made at \$1 per thousand board feet (Scribner log scale), and a few as high as \$25.

Costs of preparing and executing a small-acreage, low-volume sawlog sale, exclusive of road construction cost, vary greatly among administrative units and also depend on the characteristics of the sale area. Sale costs per thousand board feet of sawlogs are inversely related to sale acreage and to timber volume sold per acre. Sales in the areas studied usually encompass less than 40 acres, with lodgepole pine sawlog volume generally less than 8,000 board feet per acre.

The direct costs to Ranger Districts (or equivalent in State or Bureau of Land Management forests) were reported as low as \$2 in one area, but more typically are \$12 to \$25 per thousand board feet, Scribner scale. When all appropriate direct and indirect costs within Ranger Districts, Supervisors' Offices, and Regional Headquarters are included; however, total sales costs per thousand board feet of lodgepole pine sold in small tracts appear to be in the range from \$40 to \$60, with one forest reporting total costs of \$85. Such costs include not only those incurred by technicians, timber sales officers, and road planning engineers but also those incurred by specialists in silviculture, wildlife habitat, landscape esthetics, watershed quality, archeology, and law (together with all supporting staff in Supervisors' Offices and Regional Headquarters).

Volumes of forest residues resulting from sawlog sales in these problem lodgepole pine stands are generally great because most of the sawlog operators have no profitable outlet for subsawlog-size stems.

MANAGEMENT OBJECTIVES AND SILVICULTURAL CONSIDERATIONS

With virtually no exceptions, the land managers have concluded that thinning these more-or-less stagnated stands that are 70 to 100 years old is an uneconomic procedure; this is so because products recovered in such thinnings have low value, growth response is not outstanding, and thinning cost is great.

With almost no exceptions, the land managers are seeking some method to replace the stagnated and unmarketable stands of lodgepole pine with new vigorous stands of the same species--and they want to do this without expending public money. They visualize that this must be done by phased clearcutting and natural regeneration, but they have very few stumpage purchasers willing to build the necessary temporary roads, fell all diameter classes of all species, and leave the acreage with no more than 25 tons (ovendry) of slash per acre and with sufficient seed distributed on exposed mineral soil to ensure natural regeneration (fig. 3). When the managers contract such stand replacement operations, they incur costs of \$200 to \$700 per acre--costs that they find hard to justify economically. Most of the managers do not find it necessary to plant such clearcut areas if the seedbed is properly prepared, with mineral soil adequately exposed and viable seeds available from serotinous cones on the ground or from adjacent trees bearing open cones.

Figure 3--Lodgepole pine was harvested from this clearcut in south-central Colorado with a steep-slope feller-buncher. Very small stems were trampled. All slash was left on the ground unpiled and unburned. Regeneration will be natural. The access road is temporary.

Assuming that stand replacement can be accomplished with little or no expenditure of public

funds, most of the managers think that they can internally fund thinning of the regenerated stands when the trees are 15 to 20 feet tall (fig. 4); cost of such precommercial thinning is usually $60 to $85 per acre, but may be as high as $300 per acre if vegetation is dense.

Figure 4--Naturally regenerated lodgepole pine in southern Wyoming precommercially thinned at about 18 years to 350 to 400 stems per acre. In the proposed utilization problem solution slash would not be piled or burned, but would remain as shown to deteriorate slowly. Stadia rod in center foreground shows 1-foot intervals.

In virtually all cases, the managers must give great consideration to improvement of wildlife habitat, protection of stream quality, and protection of esthetic values--but these considerations are not generally seen as prohibiting planned stand replacement as long as clearcuts do not exceed 40 acres, are spaced to maintain elk or deer hiding cover, do not disturb streams, and are located and contoured to be visually acceptable. This generalization does not apply to two or three of the Wyoming-Colorado areas where recreational use is heavy and where hiding cover for elk is limited to a narrow forest of lodgepole pine bordered by sagebrush below the trees and exposed rock above.

Although controlled or wildfire might appear to offer a solution on some acreages, few managers are willing to embrace the idea of deliberately wasting the enormous tonnages of wood that would be consumed by such fires. And such fires would have limited usefulness in protecting stream quality, habitat, and esthetic quality of the forest.

SUMMARY OF THE PROBLEM

In brief, the land manager faces the problem of how to clearcut and regenerate large acreages of stagnated or otherwise unproductive stands of lodgepole pine without expenditure of public funds to cover the direct costs. Additionally, managers must accomplish this stand replacement according to a management plan without jeopardizing the other values of the forest--wildlife habitat, stream quality, and esthetic quality. Such stand replacement with vigorous new stands is done in contemplation of thinning to a prescribed stocking density when the new trees reach a height of about 15 to 20 feet. Additionally, biomass resulting from the clearcuts should yield a positive contribution to the economy--as contrasted to waste through destruction by fire, or by insects and disease.

At the same time, the industrial manager of the operation performing the clearcutting, site preparation, and utilization of the material removed faces the problem of making an appropriate profit on investment in harvesting, transport, and conversion facilities. This after-tax return should be at least 15 percent annually on the entire investment, assuming no borrowed funds.

PROPOSED SOLUTION

At the outset it should be understood that the contemplated operation in the forest is a stand replacement, not a timber sale. That is, the company planning to utilize the biomass will--in a no-cost exchange for most of the biomass on each acre--agree to:

- Build the necessary minimum-quality and temporary access roads to permit making the required clearcuts prescribed by the long-range management plan; at least in the initial decade of the plan, these clearcuts will be made on land having slopes less than 55 percent. It will be the responsibility of the land manager to construct the principal haul road serving the area.

- Shear (or saw-fell) and remove from the forest essentially all of the aboveground biomass of all trees of all species larger than 3 inches in d.b.h. (with the exception of sufficient cone-bearing branches to favor regeneration). If the stand lacks sufficient viable seed, the public land manager will be responsible to provide supplementary direct seeding at the appropriate time.

- Trample all stems 3 inches and less in d.b.h.; this should result in less than 25 tons (ovendry basis) of slash on the ground; this slash would be neither piled nor burned--simply compacted by trampling and subsequent snowfall.

- Equip feller-bunchers and skidders with treads designed to expose a maximum of mineral soil to favor natural regeneration. In areas with insufficient mineral soil exposed because they were logged in deep winter snow, or for other reasons, it will be the responsibility of the land manager to roller chop--or otherwise adequately prepare the seedbed--according to prescription.

- To avoid unnecessary drain on the forest nutrient pool, restrict pile and burn operations to landings only, where slash may accumulate.

Harvesting

Steep-slope feller-bunchers equipped with accumulators and shears (fig. 5) teamed with fast grapple skidders (fig. 6) or forwarders, capable of operating on slopes up to 55 percent, will comprise the primary harvesting equipment. In addition to felling, bunching, and forwarding (1,000 feet) about 1,400 trees per 8-hour day, these vehicles should be able to effectively trample most of the small trees during all seasons, and accomplish needed mineral soil exposure under all but deep-snow conditions.

Figure 5--Track-mounted steep-slope feller-buncher equipped with self-leveling platform carrying a boom-mounted tree shear that can accumulate sheared stems preparatory to depositing them in a bunch.

Figure 6--Track-mounted grapple skidder rapidly moving bunched trees down a steep slope.

Transport of Trees to Plant

Trees from most acreages will have small crowns and will be transported to the mill (fig. 7) with crowns attached. Stems from some stands will have such heavy crowns that they will have to be delimbed before transport.

Figure 7--Whole pines with small crowns loaded full-length on a truck for transport to mill.

Storage of Trees at the Mill

Trees will be off-loaded by crane at the mill, stored in high decks, and sprayed with water in summer when risk of fungal stain is high. Unresolved is the problem of winter retrieval from the high decks without major stem breakage under conditions when the stems freeze together into unmanageable blocks; some experienced mill managers believe that trees with crowns intact have less tendency to freeze together than limb-free stems.

Delimbing

Before passing to the debarker, all stems will be delimbed mechanically. After delimbing but before debarking, tree portions (from both live and dead trees) suitable for cabin logs will be removed by crosscut sawing and shunted into storage preparatory to hand debarking and further manufacture.

Debarking

With the exception of tree portions removed for cabin logs, all stems will then pass through mechanical ring debarkers, and the bark will be conveyed to a processing plant for conversion to soil-amendment products or to heat energy.

Stem Merchandising

From the debarkers, all stems will pass to a merchandising machine equipped with scanners and computer-controlled bucking saws designed to segment each stem into pieces of maximum value for later conversion into roundwood products such as tree props (a pointed dowel 2 to 2.25 inches in diameter and 6 to 12 feet long), post and rail products of various kinds, joist flanges (fig. 8), stud logs, and telephone or power poles.

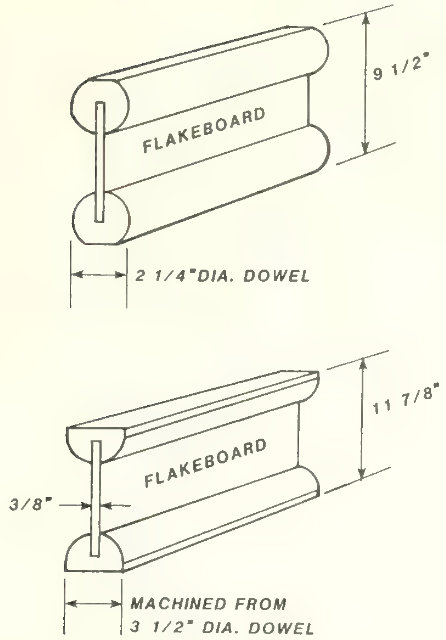

Figure 8--Joists fabricated with minimally machined lodgepole pine dowel flanges and 3/8-inch-thick flakeboard webs. By finger jointing flanges into long lengths, joists of any desired length can be fabricated. By varying dowel (or half-dowel) diameter and spacing, joists with desired stiffness and load-carrying capacity can be constructed.

Most of the output will be tree props and flanges for fabricated joists (Koch and Burke 1985) because these are high-value, high-volume products and because most of the stems will have diameters appropriate for these products. Because the market for fenceposts and rails is limited, only a small portion of total output will be converted into these products (some of which will be pressure impregnated with the preservative CCA, as required by the market).

Residues

Stembark (see Debarking, earlier) will be combined with organic wastes (perhaps sewage sludge) and processed into soil-amendment products with value sufficiently high to warrant shipment to distant markets. Alternatively, it can be burned for heat energy.

Branchwood and branchbark (most foliage will be lost during skidding and transport) will be used as fuel to warm the plant during winter, and to satisfy the heating requirements of kilns to dry joist flanges and lumber cut from the stud logs.

Most stemwood green residues will be converted to flakes 3 inches long, about 0.020 inch thick, and generally less than 1 inch wide. These stemwood residues will come from several sources:

- Thirty-two-inch-long stem sections cut from stems that have butts shattered by felling shears (32 inches, because this is a length appropriate for conversion by a disk flaker).
- Thirty-two-inch-long stem sections removed because they include short crooks.
- Eight-foot-long stem sections too defective or crooked for conversion to roundwood products (8 feet, because such bolts can be crosscut into three 32-inch lengths before flaking).
- That tapered portion (about 50 percent of each stick doweled) of stemwood removed during doweling operations; the problem of designing dowelers that will produce a residual flake having the qualities needed for flakeboard is unresolved.
- All stems of species other than lodgepole pine (for example, subalpine fir, aspen, spruce) will be crosscut first to 8-foot lengths and later to 32-inch lengths for flaking.

Unavoidably, some random-length stem sections shorter than 32 inches will result from cutting random-length stems into products that for the most part have specified lengths. These trim ends will be chipped for pulp; alternatively they can be added to the chipped branches to fuel the dry kilns and provide plant and process heat (including heat needed for the flakeboard hot press).

Also, stemwood tops with butt diameters less than 2.25 inches likely are too small for flaking and will have to be chipped for pulp or fuel. Such tops might each contain about 0.1 cubic foot of wood and have an ovendry weight of perhaps 2 pounds. This portion of harvested stemwood residue probably will total about 1 ton per acre (ovendry).

Additionally, green sawdust from the studmill and dry planer shavings from stud planing operations (as well as sawdust and shavings from manufacture of joist flanges) will help fuel the dry kilns and provide plant and process heat.

Flakeboard Manufacture

Flakes residual from manufacture of roundwood products will be dried and screened. About 80 percent of the dried flakes will be accepted for conversion into structural flakeboard (fig. 9). Fines comprising the remaining 20 percent will be routed through a suspension burner to provide heat for the flake dryer. Unresolved is the question of economic control of emissions from the suspension burner-dryer mechanism.

The manufacturing operations, and hence the scale of harvesting operations, will be sized to yield structural flakeboard production of about 100 million square feet annually, 3/8-inch basis. Such board might typically weigh about 40 pounds

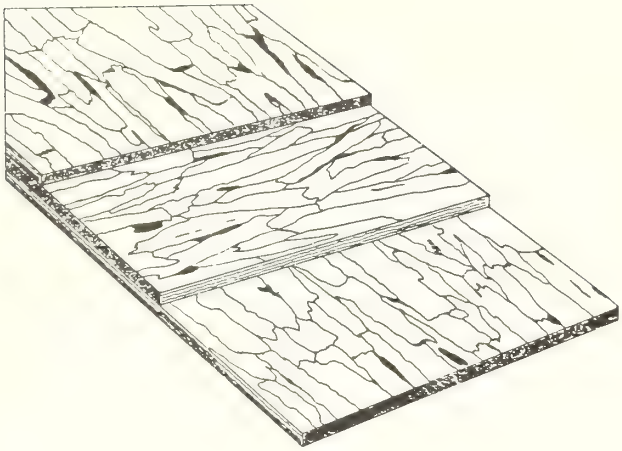

Figure 9--Structural flakeboard. Such board can have random orientation of flakes, or as shown here, be comprised of three layers each with strands oriented. In oriented-strand board, flakes in the two face layers are aligned with grain parallel to the 8-foot edges of 4- by 8-foot panels, and those in the core at right angles to this.

per cubic foot, ovendry basis. With resin and wax content subtracted, each cubic foot of board might contain 39 pounds of wood, ovendry basis.

If 75 percent of the stemwood harvested goes to the flakeboard plant, and four-fifths of this leaves the plant as salable board, then annual stemwood harvest can be estimated as 101,563 tons per year, ovendry.

If, as Montana data suggest, an average acre yields 43 tons (ovendry) of stemwood from trees larger than 3 inches d.b.h. (1,360 of such trees per acre), then the annual area to be clearcut will total about 2,362 acres.

If, however, an average acre in the Rocky Mountains yields only 31 tons (ovendry) of stemwood per acre in trees larger than 3 inches in d.b.h. (1,000 of such trees per acre), then the area to be clearcut annually will total about 3,276 acres.

Economic Feasibility

It remains to be seen whether the operation described is economically feasible. A study to make this determination is scheduled for 1987.

Comment on Scale of Operations

There are only a few locations where an operation of the scale described (2,300 to 3,300 acres to be clearcut annually) might be feasible. Needed in addition to the proposed large-scale operation, but not yet conceived, are economically viable stand replacement operations for much smaller acreages that would clearcut 250 to 500 acres per year over a plant life of 20 years.

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Biological Responses

Chaired by: Roger D. Hungerford

The biological responses that result from harvesting treatments are critical to the postharvest management of all resources on the site. Harvesting prescriptions are in fact specified to achieve particular responses that are considered desirable, and to avoid undesirable responses. Study site harvest levels of 33, 66, and 100 percent basal area removal allowed the evaluation or prediction of the biological responses that could be expected over a wide range of prescriptions in lodgepole pine. Responses of concern include changes in basic site attributes such as moisture, temperature, and soil composition, resulting changes in tree and understory vegetation composition and growth, and stand predisposition to insect, disease, or physical damage. Information discussed in this section describes various predicted consequences of alternative harvesting prescriptions in small lodgepole pine.

EVALUATING EXPECTED THINNING RESPONSE AMONG SMALL-STEM LODGEPOLE PINE STANDS

Dennis M. Cole

ABSTRACT: Expected growth and yield response and which stands to thin are important considerations for managers of overstocked, small-stem lodgepole pine stands. These considerations were examined for five stands selected as representative of the small-stem management problem in lodgepole pine. The stands were compared with computer projections of growth and yield development across many decades, considering natural stand development versus nominal 33 percent and 66 percent basal area removal through low thinnings. Although useful for evaluating potential improvement in total and merchantable yields and product potentials, the stand projections gave inconsistent results in determining thinning priorities. Two other formal approaches were evaluated. Results from the three formal approaches were compared with a subjective approach based on a composite of commonly accepted biological criteria of stand and site conditions. The Thinning Response Index provided rankings that were consistent with those from the composite of stand and site criteria generally accepted as influences on stand vigor and growth.

INTRODUCTION

Overstocked, small-stem stands like those studied in the Systems of Timber Utilization for Environmental Management Research and Development Program of the Intermountain Research Station occur in great number over large acreages throughout the range of lodgepole pine (*Pinus contorta* var. *latifolia* Dougl.). Two questions almost always asked by foresters in the lodgepole pine region about stands like these are: (1) What yields can be expected from thinning or not thinning a specific stand, and (2) what is the relative potential for biological response to thinning among a number of stands?

The first question is usually addressed by reference to variable-density yield tables, or by making a specific projection for the stand in question with a computer program such as RMYLD (Edminster 1978). The second question has usually been addressed by ranking stands subjectively after viewing them and reviewing some stand statistics such as age and stand density. In this paper I address both questions.

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Dennis M. Cole is Research Forester, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Bozeman, MT.

The first question was examined by using stand projections from the northern version of RMYLD (Cole and Edminster 1985). The second was considered by comparing three formal approaches for setting priorities for thinning with a subjective approach based on a composite of class rankings of factors commonly accepted as measures or indicators of stand and site condition. The subjective ranking was used in the comparisons instead of actual stand response, because response data are not yet available. Priorities identified by the different approaches were evaluated for biological consistency by a large number of foresters during a field visit to the stands to evaluate thinning response expectations.

METHODS

Five stands in the Phillipsburg Ranger District, Deerlodge National Forest, were selected to evaluate thinning response expectations for small-stem lodgepole pine. These were the same stands selected by workshop organizers for field visits, because they were considered representative of the small-stem management problem in lodgepole pine. Stand names were: Corduroy Creek East, Corduroy Creek West, Corduroy Creek North, Rattling Gulch, and Echo Lake. From the control (unthinned) plots of each stand, average values were calculated for a number of stand characteristics that were useful for interpretive purposes or necessary for use in equations and models (table 1). Stand inventory procedures are described elsewhere in these proceedings by Barger.

To address the question, "What yields can be expected from thinning or not thinning specific stands characteristic of the small-stem problem?" stand development was projected by 10-year growth intervals to 160 years of age with the northern version of RMYLD (Cole and Edminster 1985). Prescriptions examined were: no thinning, thinning from below to remove 33 percent of the basal area, and thinning from below to remove 66 percent of the basal area. The second question, "What is the likely order of thinning response among stands?" was considered by comparing results of three formal approaches to those of a subjective procedure based on commonly used criteria for evaluating stand and site conditions. The three formal approaches were: (1) periodic volume growth in 30 years following 33 percent basal area removal by thinning from below, according to projections of the northern version of RMYLD; (2) the Deerlodge National Forest guidelines for setting priorities for precommercial thinning projects (Joy 1986); and (3) a thinning response index based on

Table 1--Pretreatment values of factors related to stand vigor and growth

Stand	Average of dominants and codominants d.b.h.	Age	SI_{100}	Trees per acre	Quadratic mean stand diameter	Basal area	Crown Competition Factor CCF	Stand density index
	Inches	Years	Feet		Inches	Ft^2		
Corduroy Cr. E	5.33	88	78	2,750	3.83	212	303	492
Corduroy Cr. W	4.64	88	69	2,800	3.08	164	330	479
Corduroy Cr. N	3.44	88	70	7,200	2.13	173	489	600
Rattling Gulch	6.99	59	83	1,175	4.95	140	189	317
Echo Lake	3.78	88	70	5,850	2.45	214	479	616

a regression model for estimating edge-response to clearing, recently developed by Cole (1986, in press). The subjective procedure involved a composite of stand rankings for each of five stand characteristics commonly accepted as either biological influences or indicators of stand growth potential.

Growth and Yield Projections

The five test stands were projected by decade intervals to 160 years for total volume yield, total volume mean annual increment (MAI), merchantable volume yield, and average stand diameter. Three of the five stands were chosen to illustrate relationships (figs. 1-4). To lessen cluttering of the graphs, only the stands with the lowest, highest, and intermediate stand densities were plotted (Rattling Gulch, Corduroy Creek North, and Corduroy Creek West, respectively). Relationships for the Corduroy Creek East and Echo Lake stands can be visualized from the figures by bearing in mind that the curves for Corduroy Creek East would generally fall very close to the Corduroy Creek

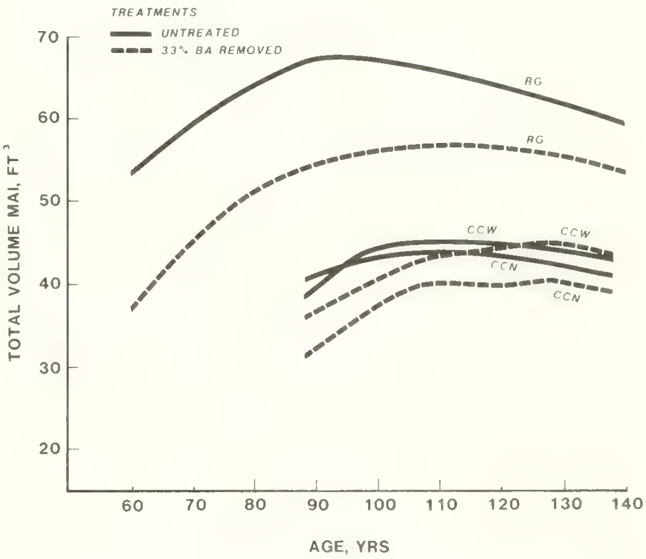

Figure 2--Projected net total volume mean annual increment (MAI), by age and treatment, at Rattling Gulch (RG), Corduroy Creek West (CCW), and Corduroy Creek North (CCN).

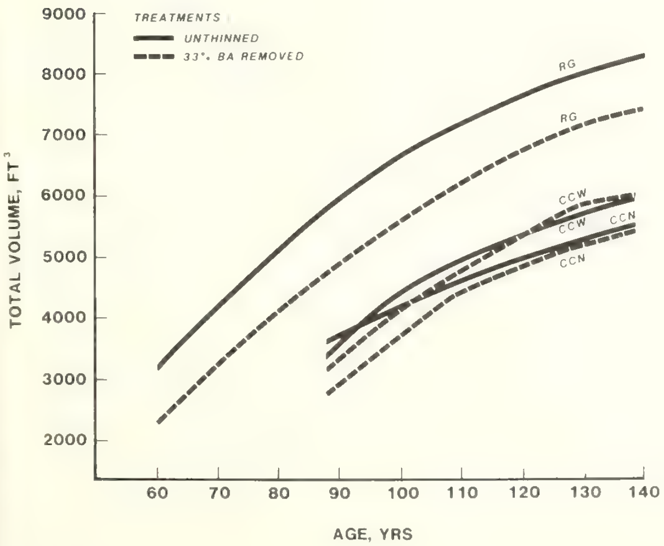

Figure 1--Projected net total cubic volume yields, by age and treatment, at Rattling Gulch (RG), Corduroy Creek West (CCW), and Corduroy Creek North (CCN).

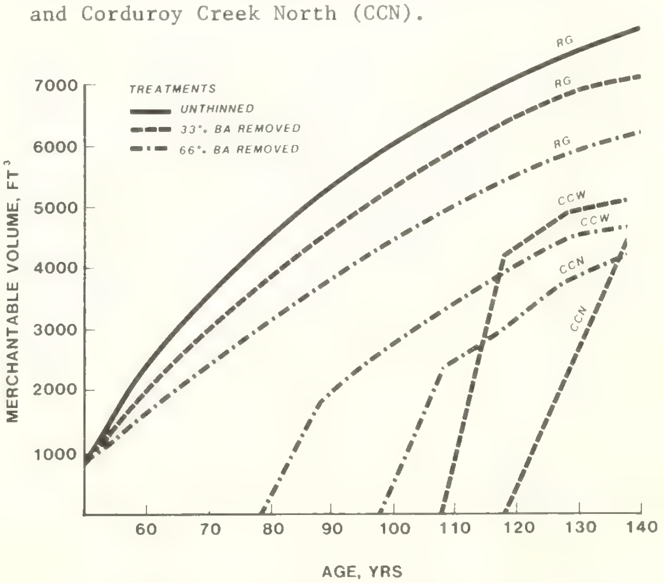

Figure 3--Projected merchantable cubic-foot volume (trees > 4.5 inches d.b.h., to a 3-inch top, by age and treatment, at Rattling Gulch (RG), Corduroy Creek West (CCW), and Corduroy Creek North (CCN).

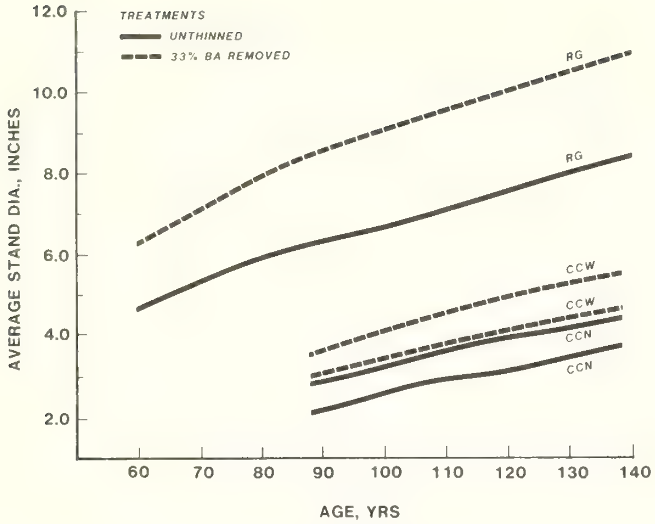

Figure 4--Projected average stand diameter in inches, by age and treatment, at Rattling Gulch (RG), Corduroy Creek West (CCW), and Corduroy Creek North (CCN).

West curves, but between them and the Rattling Gulch curves. The Echo Lake curves would fall very close to the Corduroy Creek North curves, but between them and the Corduroy Creek West curves. Differences between the stands were determined by reference to the tabular and graphical relationships provided by the projections.

Ranking Stands for Thinning

Stand Projection Approach--Projected periodic volume growth response to a fixed level of thinning was used as one approach for evaluating the relative response potential of the five test stands. The common thinning treatment assumed was a 33 percent reduction in stand basal area by low thinning. The amount of total volume growth, projected for the 30 years following thinning, was the criterion for evaluating the expected potential of the stands for thinning response relative to one another.

Deerlodge National Forest Approach--The guide developed for ranking precommercial thinning opportunities in the Deerlodge National Forest (Joy 1986) was next used to rate the test stands for thinning. This guide was considered because it incorporates many of the seldom-documented factors intuitively used by foresters for judging stands.

The guide appendix assigns scores for a combination of stand growth factors and operability factors such as aspect and slope. On the basis of the total score of all factors for each stand under consideration the guide classifies them into high, moderate, and low priority classes. Stands with scores of 20 to 28 points are considered high priority for precommercial thinning. Stands with scores of 13 to 19 are assigned moderate priority for treatment and those with scores of 9 to 12 are assigned low priority. Stands with scores of 8 or less are considered questionable and probably not scheduled for precommercial thinning. If a stand receives a zero score for any factor it is also considered to be disqualified from precommercial thinning consideration unless otherwise justified by another silvicultural analysis and prescription. On the basis of zero scores for age or average stand diameter, all five stands would be disqualified from precommercial thinning consideration. Nevertheless, the Deerlodge Guide was applied to the test stands to see if, aside from age and diameter, it provides a basis for discriminating between the stands in order of thinning priority.

Response Index Approach--A thinning response index (Cole in press), resulting from an indirect method developed by Cole (1986) for determining the relative order of expected thinning response among stands, was the third formal approach used to rank the test stands for thinning. This method is based on the response of dominant and codominant trees on edges created by clearing. This response was sampled in a wide range of stands varying in age, density, and site quality. Four alternative models based on this method explained 57 to 63 percent of the variation in response-to-clearing among dominant and codominant trees on the edges of study stands. Of these, a model explaining 63 percent of the variation in the dependent variable was selected. The model is:

$$\underline{Y} = -0.1221 + 0.1084\underline{D} + 0.0054SI_{100} - 0.0016\underline{A}$$

where

$\underline{Y}$ = common logarithm of the response of dominant and codominant edge trees, in square inches, in 10 years following clearing

SI_{100} = Site index at 100 years, as corrected for stand density (Alexander and others 1967)

$\underline{D}$ = Mean diameter of dominant and codominant trees

$\underline{A}$ = Mean age of dominant and codominant trees.

Thinning response indexes were calculated for each stand by converting the model predictions of edge response from the logarithmic form to original units, and dividing them by an indexing constant (12.0) determined as a near-maximum value of edge-response observed in the original study. The primary reason for indexing the predictions from the regression model was to dissuade users from considering the regression model as a predictor of actual response to conventional thinning. The thinning response indexes of the five stands were ranked in order of descending values to provide the basis for setting priorities for thinning potential.

Composite Factors Approach--Five characteristics were subjectively ranked for each stand: age, site index, trees-per-acre, quadratic mean stand diameter, and stand density index (Reineke 1933). Each characteristic was treated as a factor and

given two to five discrete classes, or ranks, reflecting the ranges of values represented in the five stands. For example, age was given only two classes to reflect the two distinct ages involved in the test stands; trees-per-acre, quadratic mean stand diameter, and stand density index were given five classes to reflect the greater differences among the stands in these factors.

The stand ranks determined for each factor (from table 1 data) were required to be biologically consistent with the known influence of that factor on stand growth and vigor; for example, the youngest stand was given the highest rank for age relative to the other stands; but for stocking, the stand with the least trees-per-acre was given the highest relative rank and the stand with the greatest stocking was given the lowest rank in that factor. This procedure was used for each factor and the relative rankings were reviewed onsite by a large number of workshop participants, to assure consistency with common biological understanding of the factors. A composite priority was determined by summing the factor ranks for each stand and assigning highest priority for thinning to the lowest sum of ranks, second priority to the next lowest sum, and so on.

GROWTH AND YIELD RESULTS

The volumes removed by initial thinning of typical overstocked small-stem stands are usually merchantable only as pulpwood, chips, or small roundwood products such as grape stakes. Potentials for these products are discussed by others elsewhere in these proceedings. Only the Rattling Gulch stand was indicated by projections to yield merchantable thinning volumes (trees >4.5 inches d.b.h., to a 3.0-inch top).

The economic aspects of this recovery, ranging from one-half to two-thirds of thinning volumes, also are discussed elsewhere in these proceedings. With current utilization and economic conditions, even the merchantable thinning volumes in the Rattling Gulch stand would likely be uneconomic. Growth and yield benefits of thinning small-stem lodgepole pine stands will be determined predominantly, then, by growth following thinning. Total and merchantable net cubic stand volumes and tree size in the years following thinning are useful criteria for evaluating future yields from these stands.

Net Total Cubic Volume

Differences in projected total cubic volumes among the unthinned test stands are due largely to the differences in site quality and stand density among the stands (table 1). Thinning is projected to reduce net yields of total cubic volume for all age and stand density combinations represented by the test stands for the next 50 to 80 years (fig. 1). The greatest reduction due to thinning is seen to occur in the least densely stocked stand, Rattling Gulch.

Increasing the intensity of thinning further reduced the projected net volume yield of the test stands. In general, the 33 percent basal area reduction treatment initially results in net cubic volume yield reductions of about 20 to 25 percent in moderately and heavily overstocked stands (Corduroy Creek West and North), but after about 40 years net volume recovers to about the same level as the unthinned stand (fig. 1). Because the thinning resulted in fewer trees, the near-equal volume following the 33 percent thinning after several decades would obviously be due to the larger crop trees in the thinned stand.

Projected net total volumes for the 66 percent basal area removal treatment, however, did not recover to the unthinned levels within the projection period in moderately and heavily overstocked stands--nor will either thinning treatment in lightly stocked stands increase net volume growth, relative to the unthinned condition.

Mean Annual Increment

Projected net total volume at various ages is not well-suited to show rate of change in volume growth, but projected net total volume MAI shows this well (fig. 2). Net total volume MAI is higher in less densely stocked stands and is seen to peak earlier and at generally higher levels in the unthinned than in the thinned stands.

Both figures 1 and 2 reinforce the common knowledge that when total cubic volume is the yield criterion thinning has little benefit in increasing net total volume yield at rotation--unless stands are young (for example, <40 years) and stagnated.

Merchantable Cubic Volume

Thinning markedly influences yield, when size of trees included in the yield is considered. For total cubic stand volume of all trees >4.5 inches to a 3.0-inch top, thinning is projected to produce appreciable merchantable volume yields in moderately (Corduroy Creek West) and severely (Corduroy Creek North) overstocked stands, where no merchantable yield occurs in the next 50 to 60 years without thinning (fig. 3).

At Rattling Gulch, stand density effects are minimal, thus most trees in even the unthinned stands at present are above the merchantability limits chosen for evaluation. If high enough merchantability standards (less utilization of small trees) were considered, then modest thinning intensity at Rattling Gulch would also be expected to show higher projected yields than the unthinned stand, after perhaps 40 to 50 years.

Average Stand Diameter

Average stand diameter (sometimes called quadratic mean stand diameter) is a useful characteristic for comparing growth responses among stands and treatments. Average stand diameter relates

especially well to product-size and value implications of stand development. Thinning increased the projected average stand diameters of test stands (fig. 4).

By observing the increase in the intercept for the thinned treatments of each stand in figure 4, when compared to the intercept for the unthinned stand, it is clear that most of the increase in average stand diameter from the thinnings resulted from the removal of smaller stems in the projected low thinnings. Nevertheless, by observing the increase in the slopes of average stand diameter over age of thinned versus unthinned stands, it is seen that projected thinnings in each of the test stands predict modest increases in the average diameter growth of the residual stand.

If the younger stand (Rattling Gulch) had been much more heavily stocked--or if the more heavily stocked stands (Corduroy West and Corduroy North) had been much younger--the growth in average stand diameter would have been predicted to be considerably greater; the slope of the curves in figure 4 would show greater divergence.

RESULTS FOR THINNING PRIORITY APPROACHES

Stand Projection Approach

Results of the stand projection approach to ranking stands for thinning are shown in table 2. The youngest, least-dense stand on the best site (Rattling Gulch) is expected to respond with the most periodic total volume growth and hence receives the highest indicated thinning priority.

Table 2--Thinning priorities according to projections of 30-year volume growth following thinning[1]

Stand	Periodic volume growth in total ft^3	Indicated thinning priority
Corduroy Cr. E	1,990	4
Corduroy Cr. W	2,080	3
Corduroy Cr. N	1,920	5
Rattling Gulch	2,690	1
Echo Lake	2,120	2

[1]Assumed 33 percent basal area removed from below.

The relative expectations for the other four stands are less distinct, because they vary from one another by only 200 ft^3 of volume growth; nevertheless all stands were given an indicated thinning priority or ranking, as shown in the last column, based on the magnitude of their projected periodic volume growth. The thinning priorities (rankings) in table 2 will be discussed further in comparison with the other approaches to ranking the stands for relative response to thinning.

Deerlodge National Forest Approach

Thinning priorities according to the Deerlodge Precommercial Thinning Guide are shown in table 3. There was relatively little difference in scores for most factors among the test stands, and the total scores for all five test stands varied by only one point. With the exception of the disqualification of all stands for precommercial thinning on the basis of zero factor scores, all test stands would have rated a moderate thinning priority. Noting the total stand scores in table 3, it is evident that the Deerlodge Guide did not distinguish between the thinning priorities of Rattling Gulch and the other stands, as did the growth projection approach summarized in table 2.

Response Index Approach

Stand values of the Thinning Response Index resulted in a distinct separation of several of the five test stands in terms of expected thinning response (table 4). By this approach, the Echo Lake and Corduroy Creek North stands showed nearly the same Thinning Response Index (0.25 versus 0.27) and would be considered to have essentially the same priority for thinning. This is shown in table 4 by a thinning priority of 4(a) for Echo Lake and 4(b) for Corduroy Creek North.

Composite Factors Approach

Ranking of the test stands by the subjective composite factors approach also resulted in a distinct separation of several of the stands (table 5). Like the response index approach, the composite factors approach rated the Echo Lake and Corduroy Creek North stands about the same in expected response to thinning. They were given thinning priorities of 4(a) for Echo Lake and 4(b) for Corduroy Creek North. The other three stands had considerable separation in their sum-of-ranks and thus were given distinct thinning priorities as seen in table 5.

Although the composite approach provides a rational basis for ranking these stands, it would likely prove insensitive for ranking many more stands than this. Insensitivity would occur when more than one stand received about the same composite sum of ranks--a probability that increases greatly with increasing number of stands in the comparison.

COMPARISON OF THINNING PRIORITY APPROACHES

Setting thinning priorities for the test stands by the approaches discussed here results in clear differences (table 6). Of the three formal methods--the volume growth projection, the Deerlodge National Forest Precommerical Thinning Guide, and the approach based on thinning response index--the priorities shown by the thinning response index were most consistent with those set by the composite of stand factors deemed to have biological relationships with stand growth and vigor. In fact as seen in table 6, results from these two approaches were the same.

Table 3--Stand priorities according to the Deerlodge National Forest Guide for ranking precommercial thinning projects

Stand	Age	Crown ratio	Average stand diameter	Stocking	Site index	Slope	Access	Dwarf mistletoe rating	Stand score	Thinning priority[1]
Corduroy Cr. E	[2]0	2	2	4	3	3	3	2	19	MOD[2]
Corduroy Cr. W	[2]0	2	2	4	2	3	3	2	18	MOD[2]
Corduroy Cr. N	[2]0	2	4	2	2	3	3	2	18	MOD[2]
Rattling Gulch	1	4	[2]0	2	3	3	3	2	18	MOD[2]
Echo Lake	[2]0	2	4	2	2	3	3	2	18	MOD[2]

[1]Stand score	Priority for precommercial thinning
<8	Very Low
9-12	Low
13-19	Moderate
20-28	High

[2]Zero score in one or more factors disqualifies the stand from precommercial thinning.

Table 4--Priorities of stands for thinning according to values of a Thinning Response Index based on predictions of edge response to clearing

Stand	Predicted edge response[1]	Thinning response index[2]	Thinning priority
	In^2		
Corduroy Cr. E	5.15	0.43	2
Corduroy Cr. W	3.99	.33	3
Corduroy Cr. N	3.05	.25	4(b)
Rattling Gulch	8.88	.74	1
Echo Lake	3.29	.27	4(a)

[1]Edge response = $10^{\underline{Y}}$, where $\underline{Y}$ = common logarithm of edge-response of dominant and codominant trees, in square inches, in 10 years following clearing; resulting from edge-response regression.

[2]Response index = $10^{\underline{Y}}/12.0$.

Table 5--Subjective thinning priorities for test stands by a composite of stand factors commonly interpreted as influences on growth and vigor

Stand	Relative stand rankings[1]					Sum of ranks	Composite priority
	Age	SI	Trees/Acre	QMSD	SDI		
Corduroy Cr. E	II	II	II	II	II	10	2
Corduroy Cr. W	II	III	II	III	III	13	3
Corduroy Cr. N	II	III	V	V	IV	19	4(b)
Rattling Gulch	I	I	I	I	I	5	1
Echo Lake	II	III	IV	IV	V	18	4(a)

[1]I = Highest; V = Lowest. SI = site index, QMSD = quadratic mean stand diameter, SDI = stand density index.

Table 6--Summary comparison of alternative methods of setting priorities for thinning lodgepole pine stands

Stand	Thinning priority by method			
	Composite of subjective stand factors	Volume growth projection	Deerlodge precommercial thinning guide[1]	Thinning response index from edge-response regression
Corduroy Cr. E	2	4	Moderate	2
Corduroy Cr. W	3	3	Moderate	3
Corduroy Cr. N	5	5	Moderate	5
Rattling Gulch	1	1	Moderate	1
Echo Lake	4	2	Moderate	4

[1]Strictly speaking, all test stands were disqualified from consideration for precommercial thinning because they exceeded the age maximum or average stand diameter minimum for this guide; however, the guide was applied to the test stands to see if it would indicate likely differences in thinning opportunities among the stands, aside from the thresholds for age and average stand diameters.

The Deerlodge National Forest Guide did not provide a basis for distinguishing between the test stands in thinning priority. The volume growth projection approach reversed the priorities of the Corduroy Creek East and Echo Lake stands, as compared to those from the composite factors and thinning response index approaches.

CONCLUSIONS

Growth and yield projections for small-stem lodgepole pine stands confirm, as is commonly believed, that thinning is necessary in most of these stands if merchantable yields and large trees are to be developed over a reasonable rotation. Increasing merchantable yields through thinning in these stands, though, is achieved at the expense of reduced total volume yields for periods of 50 to 100 years following thinning--the shorter periods associated with less-overstocked stands and less-intense thinning levels.

Only time will tell which of the approaches for determining thinning priorities will give the most accurate long-term results. At this point, I conclude that the composite factors approach and the thinning response index provided believable thinning priorities for the test stands. Of these two, setting priorities by thinning response index is likely to be more useful because it is not limited by the number of stands being considered. However, remeasurement of stand volumes will reveal the actual thinning response of the test stands and the relative performance of the methods considered here. Ten-year remeasurements should provide this completely objective evaluation.

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APPENDIX

PRECOMMERCIAL THINNING PROJECT RATING GUIDE (DEERLODGE)[1]

STAND ID: ______________

DATE: ______________

Age	Points	Score
0-15 years	0	
16-30 years	3	
31-50 years	2	
51-70 years	1	
71 + years	0	_____

Crown Ratio	Points	Score
Less than 25 percent	0	
25-40 percent	2	
41 + percent	4	_____

Average Stand Diameter	Points	Score
0-1.0 inch	1	
1.1-2.0 inch	3	
2.1-3.0 inch	4	
3.1-4.0 inch	2	
4.1 + inch	0	_____

Stocking (trees per acre)	Points	Score
0- 600	0	
601-1000	2	
1001-3000	4	
3001-6000	3	
6001 +	2	_____

Site Index (50-year base)	Points	Score
Less than 30	0	
30-39	1	
40-49	2	
50-59 or greater	3	_____

Slope	Points	Score
0-40 percent	3	
41-60 percent	1	
60 + percent	0	_____

Access	Points	Score
Roaded (access to stand)	3	
Less than half mile from road	2	
Half to one mile from road	1	
Over one mile from road	0	_____

Dwarf Mistletoe (lodgepole pine only)	Points	Score
*based on Hawksworth's six point rating system		
4 and over	0	
3	1	
1 or 2	2	
0	4	_____

GRAND TOTAL _____

[1]Developed by John Joy, silviculturist, Deerlodge National Forest

Stand and site conditions must be examined before using the rating guidelines to prioritize precommercial thinning projects. Existing stand and site conditions are then compared to the categories within each of the eight items, and scored according to the points listed. A rating of zero for any one item will generally be sufficient to eliminate a stand from future consideration unless a silvicultural prescription justifies treatment.

All individual item scores are added together to give a total score. The highest possible score is 28 points for lodgepole pine stands and 24 points for stands without lodgepole pine. On east-side forests only lodgepole pine has dwarf mistletoe, thus only those stands with lodgepole pine are rated on that item. Stands with scores of 20 to 28 points will be considered high priority for treatment provided that zeros are not recorded for any item. Stands with scores of 13 to 19 will be assigned moderate priority for treatment. Stands with scores of 9 to 12 will be assigned low priority. Those stands with scores of 8 or less will be considered questionable and probably should not be scheduled for precommercial thinning.

This ranking method is not intended to supplant silvicultural prescriptions but is intended to aid in the decision making procedure. The scores should enhance the prescription process and can be included as a portion of the diagnosis.

EFFECTS OF WIND AND SNOW ON RESIDUAL LODGEPOLE PINE FOLLOWING INTERMEDIATE CUTTINGS

Jack A. Schmidt and Roland L. Barger

ABSTRACT: The physical characteristics of lodgepole pine make the species particularly susceptible to wind and snow damage when dense stands are opened by intermediate cuttings. Potential damage and residual stand losses must be considered when treatments are prescribed. This paper reports wind and snow damage and losses in 16 lodgepole pine units in which intermediate harvest cuttings were made. Four types of damage were recognized: lean, windthrow, snowbend, and breakage. Factors influencing the type and extent of damage included diameter of residual trees, residual stand density, and exposure to prevailing winds by adjacent clearcuts.

INTRODUCTION

Management of natural stands of pole-size lodgepole pine is a critical problem in the Intermountain West. Needed are greater age diversity, reduction of mountain pine beetle hazard, improved growth rates, and methods of meeting various nontimber resource objectives. Intermediate harvest cutting is an important tool for helping to meet these objectives. Lodgepole pine occupies almost 13 million acres of commercial forest land in the United States, ranging from California to Canada, and eastward to the eastern slopes of the Continental Divide. The species regenerates prolifically following intense fires, forming subclimax or transitional stands. As subclimax stands the species may persist on some sites indefinitely, retained by recurrent fire and isolation from other seed sources, and will likely be managed as a climax species (USDA Forest Service 1965). On other sites, lodgepole pine is a temporary occupant; invasion by reproduction of other species is significant.

Natural reproduction following fire is typically excessively dense, sometimes reaching hundreds of thousands of trees per acre. Dense stocking and relatively rapid juvenile height growth results in slender stems (fig. 1). Mature trees have been described as averaging "7 to 13 inches in diameter and 60 to 80 ft tall" (USDA Forest Service 1965).

Figure 1--The tall, slender growth habit of lodgepole pine trees in densely stocked stands makes the species vulnerable to wind and snow damage.

Lodgepole pine tends to self-prune in the dense stands, resulting in relatively short live crowns. The slender growth habit, with live crown concentrated at the top of the tree, makes the species especially susceptible to snowbend and breakage due to wind or snow loading.

Root development in lodgepole pine is variable and depends on soil characteristics. In general, a taproot is dominant during seedling and sapling development, but does not persist beyond the juvenile years (Cochran 1985). Lateral roots provide the major support after trees reach pole size. Because of the often shallow lateral root habit, lodgepole pine is usually considered to be vulnerable to windthrow (fig. 2).

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

Jack A. Schmidt is Forester and Roland L. Barger is Program Manager, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT.

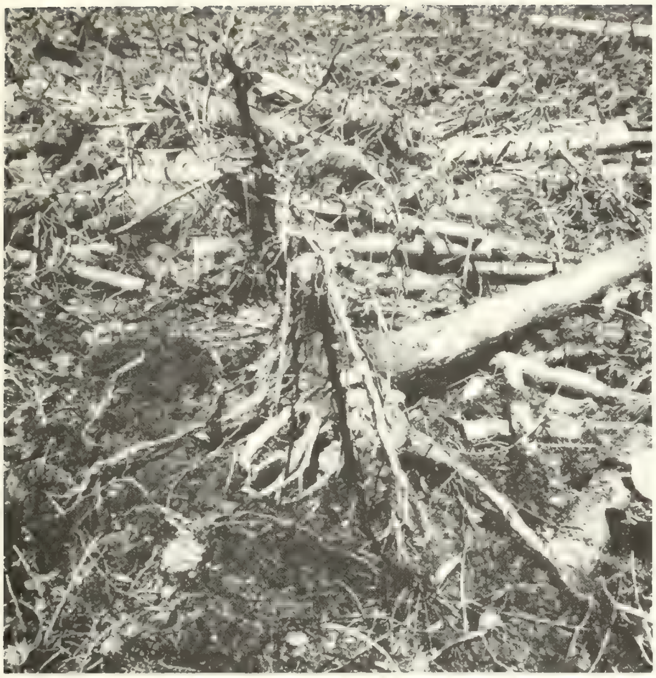

Figure 2--Shallow lateral root systems contribute to lodgepole pine susceptibility to windthrow.

Physical characteristics of lodgepole pine that predispose the species to wind and snow damage become particularly important when partial cutting or thinning treatments are proposed (Alexander 1975). Although clearcutting historically has been the dominant harvesting prescription for lodgepole pine, there is renewed interest in intermediate harvest cuttings. Thinning in pole-size stands has been shown to reduce susceptibility to mountain pine beetle attack (Amman and Safranyik 1985). Thinning in younger, vigorous pole stands also releases the residual stand to avoid stagnation and encourage accelerated growth rates. Retaining a residual stand on the site often helps meet wildlife habitat, esthetic, and other nontimber resource management objectives. This paper reports the effects of wind and snow on residual trees following different levels of intermediate harvest cutting in small-stem lodgepole pine stands in Montana.

SITE SELECTION

A major 5-year Intermountain Research Station research effort evaluated harvesting, utilization, and silvicultural alternatives in small-stem lodgepole pine. To address this problem, a series of studies was initiated to evaluate the economic feasibility and biological consequences of intermediate harvest cuttings in selected subsawtimber-size stands of lodgepole pine. One of these postharvest studies was the assessment of wind and snow damage to residual stands reported here.

Sixteen study sites were involved in the stand damage assessment, 15 of which were located in western Montana and one in southwestern Wyoming (fig. 3). Sites were initially selected to satisfy the sampling requirements for utilization and silvicultural study objectives, rather than stand damage study objectives. Consequently, such factors as position on the ridge, local wind patterns, and average snowfall were not site selection criteria. Nevertheless, the study sites represent a wide array of pretreatment stand density, tree size, and stand age. Represented are stands ranging from 3 to 7 inches in average diameter at breast height (d.b.h.), 1,000 to 8,000 green stems per acre, and 50 to 120 years in age. They are geographically distributed from the Wasatch-Cache National Forest to the Lewis and Clark National Forest (41° to 47° latitude), with study areas in four National Forests--Deerlodge, Gallatin, Lewis and Clark, and Wasatch-Cache.

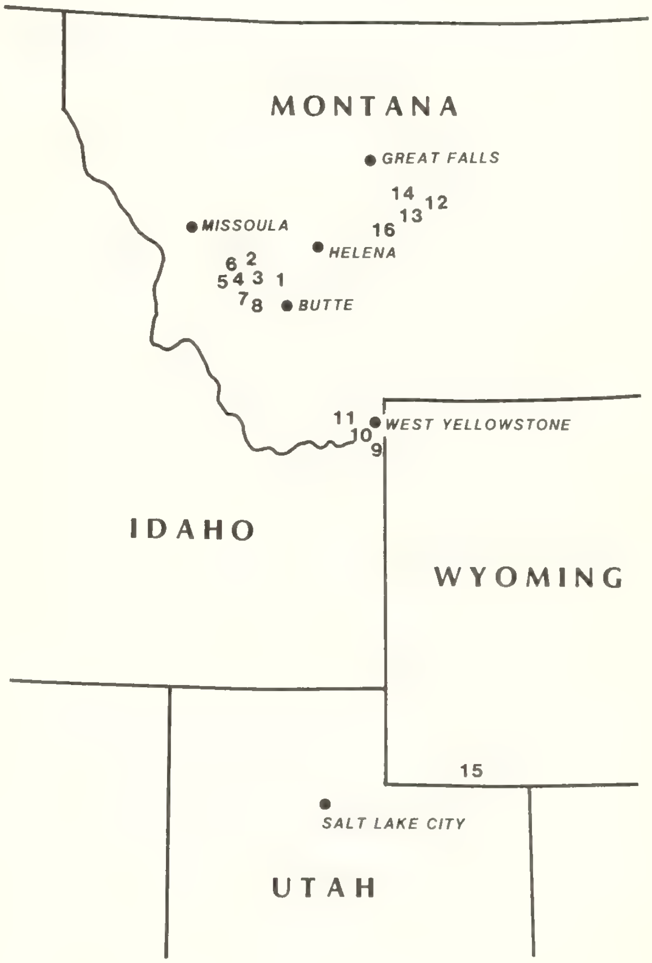

Figure 3--Study sites were geographically dispersed from the Wasatch-Cache National Forest on the south, to the Lewis and Clark National Forest on the north.

TREATMENTS

Each study area was established and laid out to include two levels of intermediate harvest cutting--33 percent and 66 percent basal area (BA) reductions--plus an untreated control. Three of the study areas included a clearcut

treatment (fig. 4). Most study areas were 5 to 10 acres in size, with single treatment units ranging from 1.1 to 3.7 acres and averaging about 2 acres each. Permanently monumented sample points were established in each study area as a basis for pre- and posttreatment inventory. Applying constant basal area reduction treatments to stands of varying tree size and density resulted in a range of residual tree spacing on the different study areas. Residual stand stocking for the study areas is indicated in table 1.

Harvesting and utilization specifications for the study areas were established in an attempt to maximize product recovery from cut stems, and to leave a clean, undamaged residual stand for subsequent long-term evaluations of tree response and growth, as well as other biological responses. All cut trees 3 inches or more in diameter at the stump had to be removed from the unit (older dead excepted). Trees smaller than 3 inches could be left on site, but had to be slashed to lengths of 6 feet or less. Equipment was allowed to enter the stands only on designated skid roads that generally coincided with study area boundaries.

Movement of stems from stump to skid road had to be by hand or by line skidding. Restrictions on use of equipment in the stand generally served to avoid or reduce damage to residual trees. Physical contact between skidding equipment and residual trees, which can result in "root-springing" and reduced tree root strength, was avoided entirely. Line skidding occasionally pulled material against residual trees, exerting some lateral force against the tree at ground level; however, such occurrences were considered minimal.

ASSESSING DAMAGE TO RESIDUAL TREES

Damage assessment focused on wind and snow damage because of their potentially devastating effect within a stand soon after cutting.

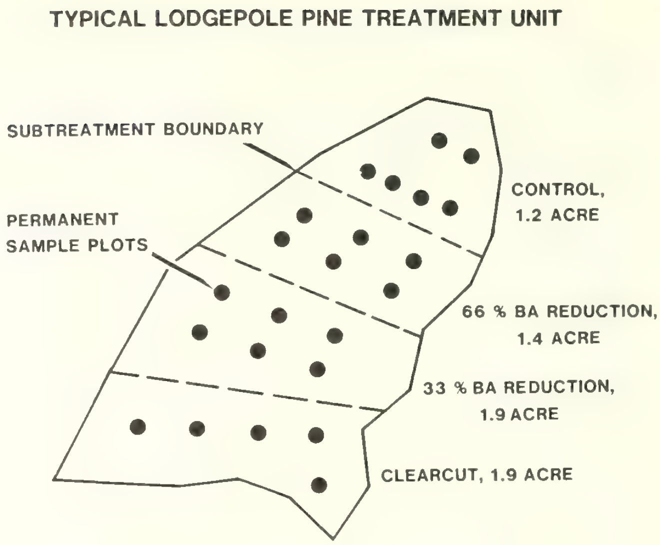

Figure 4--All study areas included a control and two intermediate cutting treatments. A few included clearcuts.

Twelve of the 16 study areas were treated during the period 1982-84, and were initially examined for damage to the residual stand in 1985. They were reexamined in 1986. The remaining four study areas were treated in 1985, and examined in 1986.

Four types of damage (fig. 5) recognized in the assessment were:

1. leaning trees
2. uprooted trees
3. snowbent trees
4. broken trees

The damage appraisal procedure involved a systematic examination of each treatment unit (control; 33 percent removal; 66 percent

Table 1--Residual stand stocking in green stems per acre, for all treatments

Study area	Control	33 percent BA removal	66 percent BA removal
	Number		
1. Spring Emery	3,535	1,500	943
2. Ballard North	4,028	1,149	250
3. Ballard South	1,929	936	407
4. Corduroy East	2,750	1,091	475
5. Corduroy West	2,800	1,943	614
6. Corduroy North	7,201	3,264	1,144
7. Rattling Gulch	1,175	400	241
8. Echo Lake	5,850	1,601	686
9. South Flat	1,650	1,036	429
10. Getcho	1,877	451	207
11. Reas Pass	1,332	402	190
12. Dry Fork East	4,967	1,327	544
13. Dry Fork West	3,976	1,578	600
14. Currie North	2,065	930	350
15. Cottonwood	2,200	932	321
16. Wet Park	4,620	701	315

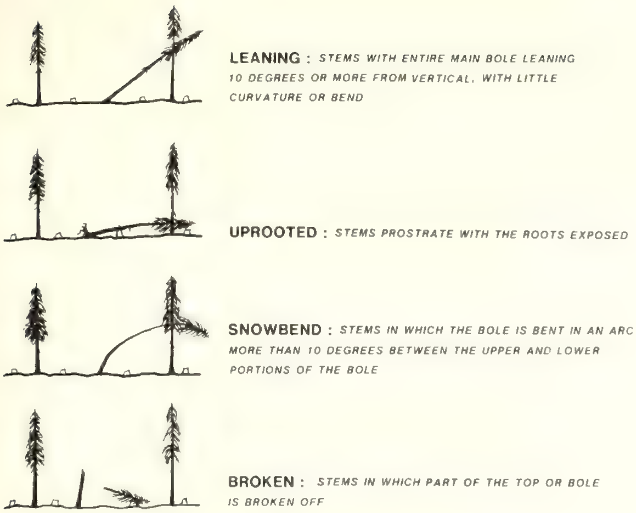

Figure 5--Four types of tree damage were used to evaluate effects of wind and snow on lodgepole pine.

removal) in a study area. All trees within each treatment unit were observed for damage. Damaged and down trees were marked to aid subsequent remeasurement, and the location of the tree was plotted on a field map of the unit. Observations and measurements for each damaged or down tree included:

--type or category of damage (fig. 5)

--tree d.b.h.

--degree of lean, for leaning trees

--magnetic azimuth of lean, or direction of fall for prostrate trees.

Assessment results reported here are necessarily limited to the relatively short postharvest time period of 1 to 3 years. Periodic assessments are planned that will evaluate damage over an extended time period.

Field data were edited and summarized for each study area and were subsequently summarized by treatment, type of damage, and tree diameter. Variables suspected of being significantly related to degree and type of damage included treatment prescription (level of thinning), diameter of residual trees, and exposure of the study area to direct wind.

RESULTS AND DISCUSSION

Type of damage varied considerably among study areas, but in total was relatively evenly distributed among the four classes.

Type of damage	Percent of damaged stems
Uprooted and down	30.0
Snowbent	29.7
Leaning	27.5
Broken stem	12.8
	100.0

Lean, snowbend, and uprooting each accounted for about 30 percent of the total observed damage, with breakage making up the balance. Contrary to a rather remarkable recovery from snowbend observed for young western larch (Schmidt and Schmidt 1979), the age and condition of these wind- and snow-damaged lodgepole pine make it highly improbable that they will ever recover from any of the four types of damage described in this study.

As expected, a strong relationship existed between tree d.b.h. and susceptibility to certain kinds of damage. A tree 7 inches in diameter, for example, is unlikely to snowbend; however, given the right wind conditions, it may be a likely candidate for uprooting. The following tabulation reflects observed relationships between type of damage and residual tree diameter.

Type of damage	Average d.b.h.
	Inches
Uprooted and down	4.8
Leaning	4.6
Broken stem	3.3
Snowbent	2.7

In general, the larger trees were more susceptible to wind damage (lean, windthrow); smaller trees were more susceptible to damage (breakage, snowbend) in which snow loading is a major factor.

Intermediate cutting of any kind increases the potential for wind damage in many timber types. With a typically shallow lateral root system, lodgepole pine can be particularly prone to wind damage following thinning (Alexander and others 1983). As the level of tree removal increases, leaving a more open stand, the stand becomes more susceptible to the effects of wind and the potential for damage increases (fig. 6). Damage observed in the inventoried treatments substantiates the relationship between level of basal area

Figure 6--Intermediate cutting treatments reduced basal areas 33 percent (left) and 66 percent (right).

reduction and degree of damage (table 2). Percent of residual trees damaged or uprooted ranged from negligible (0.04 percent) for the controls to 3.24 percent in the 66 percent basal area reduction treatment units. Uprooting of trees was the greatest single type of damage.

Table 2--Percent of residual stems damaged within each treatment, all study areas combined

Types of damage	Control	33 percent BA removal	66 percent BA removal
Leaning	<0.01	0.24	0.87
Uprooted	<0.01	.29	1.34
Snowbend	.02	.06	.48
Broken	.02	.36	.55
Total damaged	0.04	0.75	3.24

Although total damage to residual units was relatively small, it varied substantially among treatment areas. Damage ranged from 0 to more than 47 percent of the residual stems (table 3). The pattern of increasing damage with increase in basal area reduction generally remained true, further substantiating that relationship. Areas sustaining the highest levels of damage were also generally those in which treatments resulted in the widest postharvest tree spacing.

Winds in a geographic area typically follow a consistent pattern, which influences damage likely to occur (Alexander 1975). In all likelihood, storm fronts cause most of the damage. The dominating influence of wind direction on damage in the study areas is clearly demonstrated by plotting the average direction of lean or fall of damaged and down trees (fig. 7). As indicated, prevailing winds in the geographic area represented by sampled stands are from the northwest (approximately 315° magnetic azimuth). Direction of lean or fall in the study areas is essentially opposite that direction in all cases.

Unprotected exposure, such as that along a clearcut, and direction of wind in relation to the timber boundary have also been identified as principal factors influencing extent of wind damage (Alexander 1986). Clearcut treatments included on three of the study areas (as illustrated in fig. 4) allowed a limited assessment of their effect on adjacent thinned units. The juxtaposition of clearcut and thinned treatments created three different exposures to prevailing winds, corresponding roughly to 0°, 45°, and 90° to prevailing wind direction (fig. 8). The associated levels of tree damage in the exposed treatment areas were:

Angle between exposed treatment area and wind direction	Percent of stems damaged
0°	<1
45°	3
90°	47

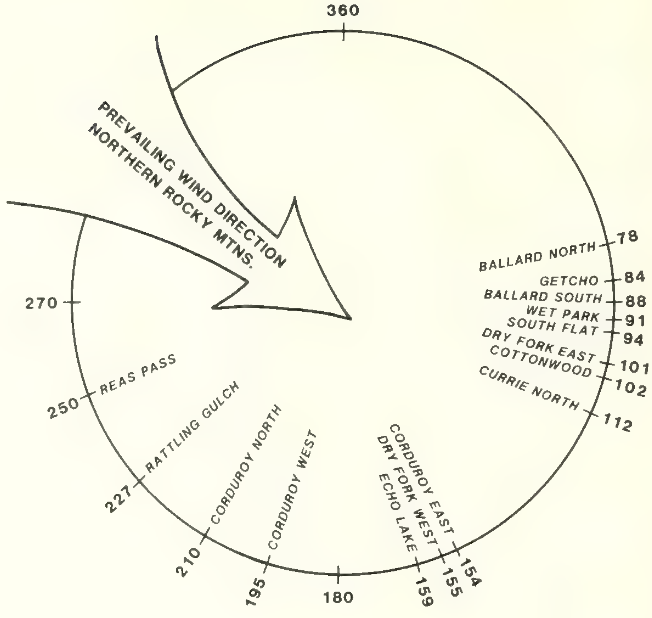

Figure 7--The relationship of average direction of lean or fall of lodgepole pine trees in relation to wind direction.

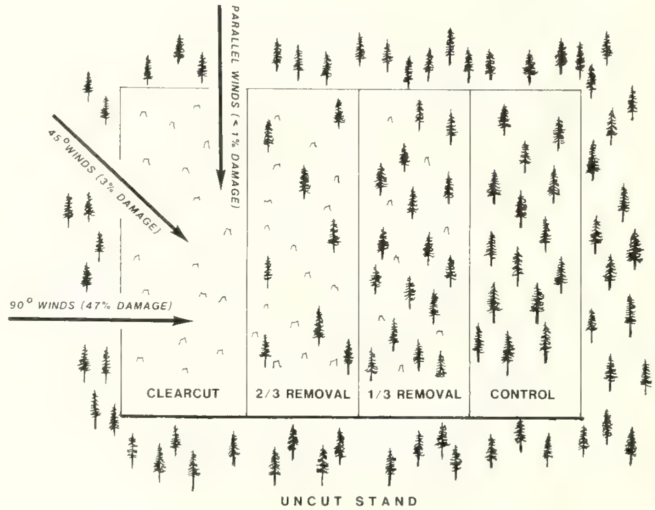

Figure 8--Direction of wind, in relation to the exposed face of treatment areas, affected the level of damage caused by wind.

The extreme influence of exposure to winds blowing across a clearcut at a 90° angle to the face of thinned areas is illustrated in figure 9. At the time of measurement, 30 percent of the stand left after cutting had blown down. Virtually all of the remaining stems exhibit significant lean away from the prevailing wind.

Table 3--Percent of residual stems damaged within each study area

Study area -treatment	Type of damage				Percent damaged
	Leaning	Uprooted	Snowbend	Broken	
Spring Emery					
-Control	0	0	0	0	0
-33 percent reduction	0	0	0	0.11	0.11
-66 percent reduction	0	0	0	.22	.22
Ballard North					
-Control	0	0	0	0	0
-33 percent reduction	0	0	0	.24	.24
-66 percent reduction	5.0	7.25	1.00	1.25	14.50
Ballard South					
-Control	0	0	0	0	0
-33 percent reduction	0	0	0	.36	.36
-66 percent reduction	0	0	0	0	0
Corduroy East					
-Control	0	0.03	0	0	.03
-33 percent reduction	0.15	.24	0.05	.24	.68
-66 percent reduction	.15	.15	0	0	.30
Corduroy West					
-Control	0	0	.03	.05	.08
-33 percent reduction	.06	0	.03	.24	.33
-66 percent reduction	.10	.10	0	.10	.30
Corduroy North					
-Control	0	0	0	0	0
-33 percent reduction	0	0	0	.23	.23
-66 percent reduction	0	0	.05	.16	.21
Rattling Gulch					
-Control	0	0	.08	0	.08
-33 percent reduction	1.73	1.54	.19	0	3.46
-66 percent reduction	.28	2.76	0	0	3.04
Echo Lake					
-Control	0	.04	0	.14	.18
-33 percent reduction	.06	.03	.26	1.50	1.85
-66 percent reduction	.58	.64	1.28	1.40	3.90
South Flat					
-Control	0	.04	.04	0	.08
-33 percent reduction	2.47	.48	.18	.18	3.32
-66 percent reduction	2.44	1.79	.33	.16	4.72
Getcho					
-Control	0	0	0	0	0
-33 percent reduction	1.48	.49	0	.86	2.83
-66 percent reduction	3.93	1.21	.30	0	5.44
Reas Pass					
-Control	0	0	0	0	0
-33 percent reduction	.19	.76	.19	.19	1.33
-66 percent reduction	0	2.17	0	0	2.17
Dry Fork East					
-Control	0	0	0	0	0
-33 percent reduction	0	0	.24	.65	.89
-66 percent reduction	0	.17	2.51	2.34	5.01
Dry Fork West					
-Control	0	0	.06	0	.06
-33 percent reduction	0	0	.05	.20	.25
-66 percent reduction	.28	0	1.53	1.81	3.62
Currie North					
-Control	.04	0	.30	.19	.53
-33 percent reduction	0	0	.18	.45	.63
-66 percent reduction	0	0	.66	0	.66
Cottonwood					
-Control	.02	0	0	0	.02
-33 percent reduction	.12	.04	0	.12	.28
-66 percent reduction	.32	.11	0	0	.43
Wet Park					
-Control	0	0	0	0	0
-33 percent reduction	2.57	.57	0	.10	3.24
-66 percent reduction	16.10	30.16	0	.91	47.17

Figure 9--The intermediate cutting area (foreground) adjoins a clearcut and is oriented directly (90°) into the most common wind direction. Windthrow and lean are severe.

CONCLUSIONS

Intermediate cuttings in younger, overstocked lodgepole pine stands are likely to be of continuing interest to land managers. Any consideration of silvicultural prescriptions should include careful evaluation of the possibility of wind and snow damage to the residual stand. The conclusions of this study should be helpful in such evaluations.

Conclusions supported by results of this study include:

1. Intermediate cutting does not necessarily mean that extensive wind and snow damage will occur. Relatively little wind and snow damage was observed after 3 years in this study--the only significant amounts being associated with those intermediate cuttings that were subjected to winds sweeping across adjacent clearcuts.

2. The intensity of intermediate cutting influenced the amount of wind and snow damage only modestly, with greater damage associated with heavier cutting.

3. Size of residual trees was associated with the type of damage that occurred; larger diameter trees suffered more lean and windthrow, and smaller trees more snowbend and breakage.

4. The position of intermediate cuttings in relation to adjacent clearcuts and wind direction appeared to be the factor most closely associated with the wind damage recorded in this study. If wind damage is to be minimized in intermediate cuttings adjacent to clearcuts, exposure to winds should be minimized by positioning intermediate cuttings upwind of clearcuts or limiting angle of exposure of stand edges to expected wind direction to less than 45°.

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WATER STRESS RESPONSE AFTER THINNING LODGEPOLE PINE STANDS IN MONTANA

Steven W. Running and Bryan L. Donner

ABSTRACT: Seasonal development of leaf water stress in thinned stands of lodgepole pine (Pinus contorta var. latifolia Engelm.) was compared to adjacent controls at three sites in Montana. Each stand was thinned to varying densities in the fall of 1982 or spring of 1983. Predawn leaf water potential measurements were taken monthly in the summers of 1983 and 1984 using the pressure chamber to determine plant water stress differences between thinned and unthinned stands. Late summer leaf water potential was significantly higher (0.17 to 0.35 MPa) in the thinned stands than in the controls. Computer simulation using the DAYTRANS/PSN ecosystem model suggested that 21 percent greater seasonal photosynthesis could occur in these trees as a result of the approximately 0.3 MPa higher plant water potential measured and additional radiation available to remaining trees. Based on estimated carbon budgets, this additional photosynthate could substantially increase the amount of carbon allocated to stem growth in these trees.

INTRODUCTION

Lodgepole pine (Pinus contorta) sites in the Northern Rocky Mountains typically are dry during late summer because of long periods with little precipitation. Thinning may improve site-water relations by reducing total stand transpiring surface area and live root density within the soil, thus increasing available water for residual trees. Canopy interception is also reduced, allowing a greater amount of rainfall to reach the soil surface. Sucoff and Hong (1974) reported an 18-year-old red pine (P. resinosa) plantation with greater leaf water potential and soil moisture content in a thinned stand than in an unthinned stand. Lopushinsky (1975) cited unpublished data by Seidel in Oregon that showed thinned lodgepole pine at midday had slightly higher moisture stress than an unthinned plot, attributed to increased exposure of the residual trees. An increase in soil moisture content following a thinning has been reported in lodgepole pine stands (Dahms 1971, 1973), red pine stands (Bay and Boelter 1963), and ponderosa pine (P. ponderosa) stands (Helvey 1975; Orr 1968).

Our study tested this hypothesis: Thinning overstocked, middle-aged lodgepole pine stands on water-limited sites in Montana will significantly reduce the water stress of the residual trees. We expected that crown ratio would also affect response. Further, reduced water stress would allow increased seasonal photosynthesis that would ultimately produce accelerated growth of the residual trees.

METHODS

Study Areas--The three selected study areas are referred to as Lubrecht (Lubrecht Experimental Forest), Rattling Gulch, and West Dry Fork. The Lubrecht site is located in the Garnet Range about 50 km east of Missoula. The stand originated from a postlogging fire in 1932 and grows on glacial lake sedimentary deposits. The Rattling Gulch site is in the Deerlodge National Forest, 25 km northwest of Philipsburg, MT. The stand grows on a midslope alluvial fan. The West Dry Fork site is about 6 km east of the town of Monarch in the Lewis and Clark National Forest in the Little Belt Mountains of central Montana. The stand is on a midslope Tertiary deposit of weathered limestone. The habitat type for the Lubrecht and Rattling Gulch sites is Pseudotsuga menziesii/Vaccinium caespitosum, and West Dry Fork is Pseudotsuga menziesii/Linnaea borealis (Pfister and others 1977).

These stands were thinned to varying densities in the fall of 1982 and early spring of 1983. Stand and site characteristics are summarized in table 1.

Basal area of all stands was very similar at 29 to 33 m^2/ha (table 1). Initial stocking densities were quite different for Lubrecht and Rattling Gulch at about 2,000 stems/ha and West Dry Fork at 12,000 stems/ha. Diameters and heights of trees at West Dry Fork are different than at the other two sites (table 2).

Sampling Procedures--The Lubrecht site consisted of one control and three treatments where varying amounts of basal area were removed. Rattling Gulch and West Dry Fork each had two thinning treatments in addition to the control. Ten sample trees were selected in each response unit. Response units are referred to as the control or by the percentage of basal area removed (for example, 37 percent and 48 percent at Rattling Gulch).

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Steven W. Running is Associate Professor, School of Forestry, University of Montana, Missoula. Bryan L. Donner is Forester, Southern Forest Experiment Station, Forest Service, U.S. Department of Agriculture, Starkville, MS.

Table 1--Study area stand and site characteristics

Feature	Study area: Lubrecht	Rattling Gulch	West Dry Fork
Initial leaf area index	5.1	5.5	6.3
Initial basal area (m^2/ha)	29.3	33.5	27.2
Basal area reductions (percent)	42	37	42
	50	48	78
	72		
Initial stocking density (stems/ha)	2,000	2,500	12,000
Residual stocking densities	270	600	1,480
(stems/ha)	560		
	1,090	990	3,900
Average stand age	49	60	58
Elevation (m)	1,250	1,700	1,600
Slope (percent)	5-15	0-10	30-35
Aspect	NW	W	NNE
Mean annual precipitation (cm)	45	46	50
Soil subgroup	Typic Eutroboralf	Typic Cryochrept	Typic Cryoboralf

Table 2--Average dimensional characteristics of sample trees

Study area and category	Characteristic: n	D.b.h.	Height	Crown width	Average live crown ratio
		cm	Meters	Meters	Percent
Lubrecht					
LCR: >55 percent[1]	20	20.4	16.1	4.0	62
<45 percent	20	12.9	14.7	1.8	30
Rattling Gulch					
LCR: >55 percent	15	18.6	15.7	3.2	62
<45 percent	15	12.6	14.6	1.3	39
West Dry Fork					
LCR: >55 percent	15	11.9	10.6	2.2	63
<45 percent	15	7.1	8.5	1.1	44

[1]LCR = contrasting live crown ratio. Used here to choose individual sample trees.

Individual sample trees were chosen primarily to fit two contrasting live crown ratio (LCR) categories of 55 to 75 percent and 25 to 45 percent. The categories were selected to determine if leaf water potential differences existed between trees with high and low leaf areas. The categories are referred to as the less than 45 percent category and the greater than 55 percent (table 2). Half of the 10 sample trees in the units fell in each category. Care was taken in sample tree selection to avoid extremes of shading or open areas.

Sample tree dimensions were measured before leaf water potential measurements began. Diameter at breast height (d.b.h.), total height, and height to the base of the live crown were measured using standard forest inventory equipment. LCR was calculated by dividing live crown length by total tree height. Increment borings for age were taken after all leaf water potential measurements were completed. Leaf area index of the stands before thinning was determined using regression equations based on d.b.h. developed by Gholz and others (1979) in Oregon. Average dimensional characteristics for each LCR category and sample sizes at the three study areas are presented in table 2.

Predawn leaf water potential measurements in 1983 were taken four times on a monthly basis beginning in June. All monthly data collection at the three sites was conducted within 5 days. An abbreviated sampling procedure was used in 1984 to verify results obtained the previous summer. Two sampling sessions were conducted at Lubrecht and West Dry Fork, and one session at Rattling Gulch, all similar to those conducted in 1983.

Each tree was sampled only once per session and no regard was given to canopy position when the sample twig was removed. A pressure chamber was used to estimate leaf water potential using standard techniques (Ritchie and Hinckley 1975).

To interpret the effect of precipitation on leaf water potential, meteorological data were obtained from U.S. Department of Commerce (1984) publications for the closest stations to each site. The main weather station for the Lubrecht Experimental Forest was 0.6 km from the Lubrecht study site. Forest Service weather stations are about 25 km southeast of and 90 m lower than the Rattling Gulch site and 5 km southwest of and 10 m lower than the West Dry Fork site.

An associated study conducted by other University of Montana School of Forestry researchers concerned seasonal soil moisture depletion at the Lubrecht site in 1983. These data were used to compare soil moisture depletion with leaf water potential response resulting from varying basal area removals. Nine neutron-probe access tubes were located in each response unit. Soil moisture (percent volume) was measured weekly from May 1 to November 8 at six depths ranging from 0.15 m to 1.52 m.

Statistical Analysis--Mean monthly leaf water potentials for each response unit were compared for statistical significance. Individual, one-tailed tests were performed to evaluate significant differences between the control and particular treatments, with a null hypothesis that treatment trees had no greater water potential than trees in the control treatments. A two-tailed test suggested significant leaf water potential differences between live crown ratio categories within each response unit on a given date. Significance was tested at the 95 percent confidence level. Analysis was conducted using the SPSSx Batch System.

Simulation Study--After observing water stress recovery of thinned stands we asked what effect this reduced stress might have on tree growth rates. Rather than waiting 5 to 10 years and observing growth release, we hypothesized that the reduced water stress and reduced canopy shading should allow greater seasonal photosynthesis to occur in these typically water-limited forest types. This hypothesis was most readily tested by computer simulation of photosynthetic response to our measured water stress data.

We used DAYTRANS/PSN, a daily resolution model of a tree water balance developed over the last 10 years (Running 1984a; Running and others 1975) that incorporates the photosynthesis equations in FAST-P, a model of conifer gas exchanged developed by the Swedish Coniferous Forest Project (Lohammar and others 1980). Complete documentation of DAYTRANS/PSN is available (Running 1984a), and a number of applications of the model similar to that in this study have been completed (Graham and Running 1984; Knight and others 1985; Running 1984b).

Two simulations were made using the DAYTRANS/PSN ecosystem model. First, a normal run was made to represent seasonal water stress and photosynthesis for a tree in the control stands. Second, the available rooting zone water supply was manipulated so that predawn leaf water potential was 0.3 MPa higher at the end of the summer, the general response shown by our field data. Leaf area removal of 50 percent for a thinned stand was programmed into the canopy radiation submodel, and seasonal water potentials and photosynthesis recomputed. Site conditions and the meteorological data required to run DAYTRANS/PSN were from the Lubrecht stand. However, these simulations were not meant to predict the response for any single study area, but rather to give a general interpretation of the potential growth response of a tree to reduced water stress and increased light availability.

RESULTS AND DISCUSSION

Leaf Water Potential and Thinning--Predawn leaf water potentials at all sites were usually lower in the controls than in any of the thinned units during both summers (figs. 1, 2, 3). In these figures, more negative (lower) leaf water potentials indicate greater water stress. At least one treatment produced significantly greater leaf water potentials than in the adjacent control for all measurement sessions except for West Dry Fork in June 1983 and Lubrecht in July 1983. In the Lubrecht stand, which is water-limited, when more water is made available, the remaining trees have reduced water stress. Tree water stress was proportional to basal area removed, with trees in the most dense stand having the greatest water stress (fig. 1). Very heavy rainfall in July caused leaf water potentials in all units to recover above -0.8 MPa with no significant differences between units. Drier August and September conditions decreased water potentials thus increasing water stress in all units, but most dramatically in the control. In 1984, trees in the control again had the greatest water stress.

Water potentials in the three units at Rattling Gulch responded similarly throughout both summers (fig. 2). The control and treatment water potentials were low in June but increased in July and August of 1983, due to rainfall of 14.5 cm during that period, double the historical average. The control water potentials were significantly less than the -48 percent unit in every measurement throughout the summer. The greatest difference between these two groups was 0.23 MPa in September. Basal area removals at Rattling Gulch were very similar, 37 percent and 48 percent, so both treated stands had similar water potential recovery. The one data set taken in July 1984 to verify the 1983 water stress recovery patterns showed a 0.2 MPa difference between the treatments and the control.

Of the three study areas, the West Dry Fork site consistently had the most significant differences between the control and the treatments (fig. 3). No early summer increase in leaf water potential occurred there in 1983 as it did at the other two sites. Precipitation in 1983 was about normal except for July. Precipitation was 120 percent above the normal of 4.37 cm in July 1983, which allowed leaf water potentials to stay unchanged

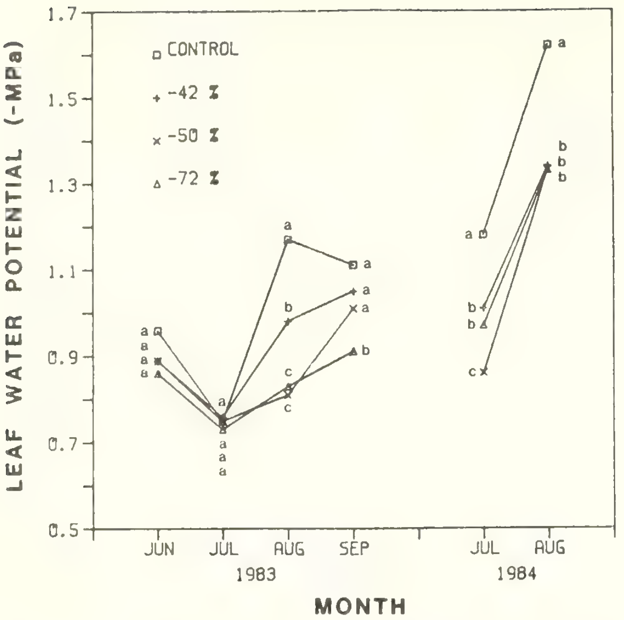

Figure 1--Seasonal trends in predawn leaf water potential by response unit, Lubrecht site. More negative leaf water potential indicates greater water stress. Treatments indicate percentage of basal area removed. Each point is the mean of 10 measurements. Means are considered significantly different (at 95 percent confidence level) if labeled by different letters.

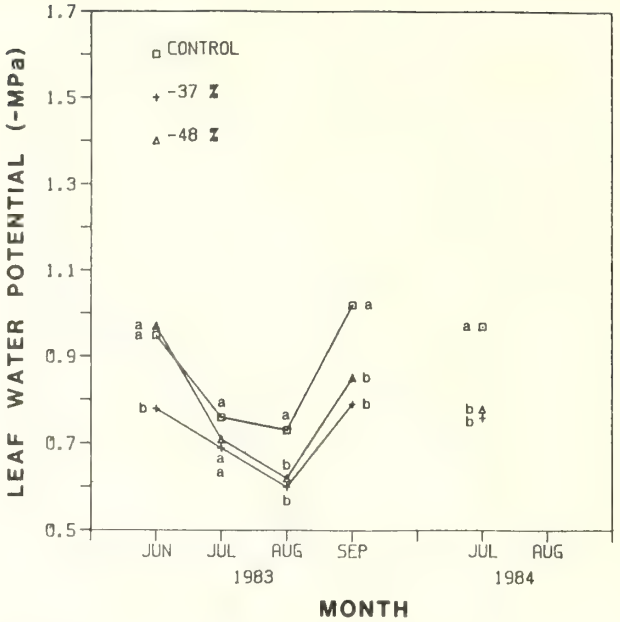

Figure 2--Seasonal trends in predawn leaf water potential by response unit, Rattling Gulch study site. More negative leaf water potential indicates greater water stress. Treatments indicate percentage of basal area removed. Each point is the mean of 10 measurements. Means are considered significantly different (at 95 percent confidence level) if labeled by different letters.

from June. However, July 1984 was extremely dry with only 0.41 cm total rainfall, which resulted in leaf water potentials averaging 0.36 MPa lower than July 1983. The remaining summer precipitation was relatively close to historical averages at the West Dry Fork site. The control stand had lower water potentials than the treatments in every measurement session except June 1983, and 0.35 MPa lower than the 78 percent unit for three of the six measurements. Water potentials increased in proportion to basal area removal in every case except June 1983.

These results appear to confirm the initial hypothesis. If more trees are removed the remaining trees have reduced water stress, thus the more room made available for the residual trees the more water is available. The significantly increased leaf water potential in lightly thinned stands (West Dry Fork) or stands thinned from low initial densities (Lubrecht and Rattling Gulch) indicates the sensitivity of the residual trees' water relations to reduced root competition.

The live crown ratio (LCR) did not appear to have a general effect on the ability of residual trees to recover predawn leaf water potential. Significant differences between the two LCR categories for a particular date and response unit were few and contradictory. The less than 45 percent LCR category sometimes had a greater mean leaf water potential than the greater than 55 percent LCR category; at other times the responses were reversed. We hypothesize that root/crown equilibrium was established in all trees in a stand before thinning, therefore increased soil moisture availability would not produce variable

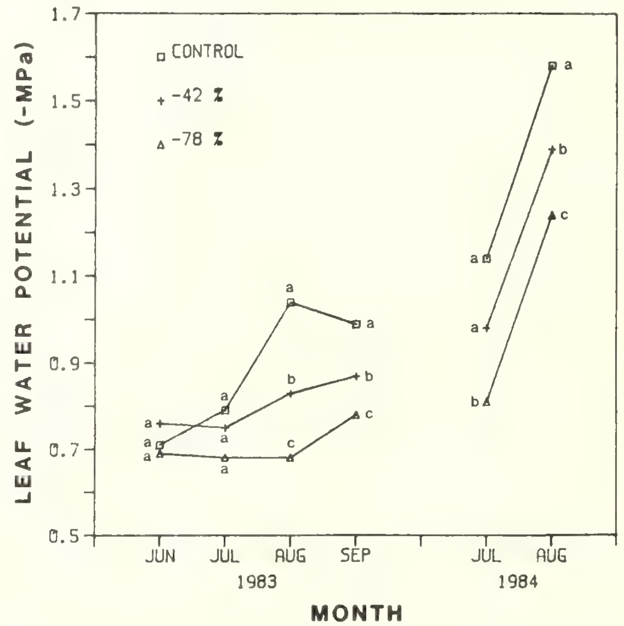

Figure 3--Seasonal trends in predawn leaf water potential by response unit, West Dry Fork study site. More negative leaf water potential indicates greater water stress. Treatments indicate percentage of basal area removed. Each point is the mean of 10 measurements. Means are considered significantly different (at 95 percent confidence level) if labeled by different letters.

recovery by different trees, as evidenced by the small variability in the pressure chamber data.

<u>Soil Moisture and Thinning</u>--To see how soil water availability is influenced by thinning, results from a companion study are shown in figure 4. Three points are notable:

1. Very little moisture was used from below 1 m (3 ft) in depth. This is interesting because these trees were starved for water and yet their roots did not go deeper to get more water.

2. The highest water depletion was in the zone from 0.3 to 0.5 m (1 to 1.5 ft).

3. Soil moisture depletion was roughly proportional to the amount of thinning--where more trees were removed less water was withdrawn from the soil.

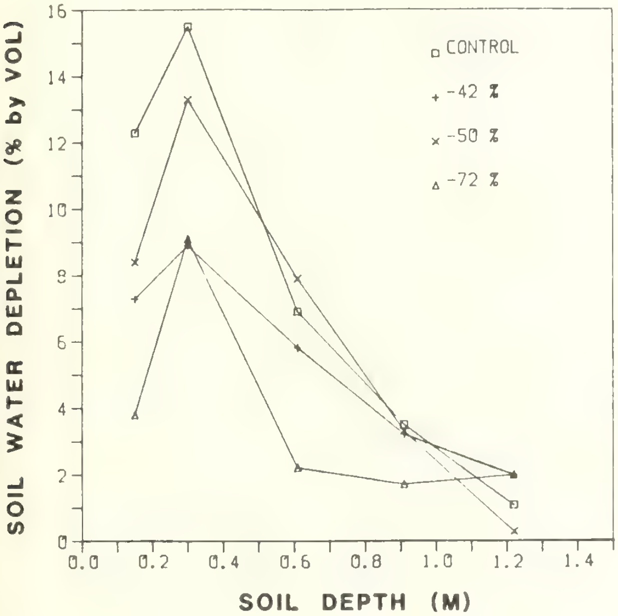

Figure 4--Seasonal soil water depletion, Lubrecht Experimental Forest. Depletion amounts were derived from the difference in soil moisture content on May 15 and September 24, 1983. Treatments indicate the percentage of basal area removed.

<u>Simulation Results</u>--The effects of thinning on leaf water potential and soil water depletion are interesting. But to answer the question of what this means to foresters in terms of growth, simulation of photosynthesis was used. An estimate of additional photosynthesis is about as close as we can get to growth without getting actual measurements.

The DAYTRANS/PSN model calculated a minimum predawn leaf water potential of -1.51 MPa at the end of the season for the control stand scenario, roughly the midpoint of the range of -1.18 to -1.62 MPa found for the 2 years at the Lubrecht site (fig. 5). The model calculated a seasonal photosynthesis of 89 mg CO_2/cm^2 leaf area for the control trees, and 108 mg CO_2/cm^2 for the thinned trees, or a 21 percent increase in overall photosynthate production for a tree in the thinned stand (fig. 6).

The prediction by DAYTRANS/PSN of 21 percent additional photosynthate availability initially does not seem very significant. However, in the

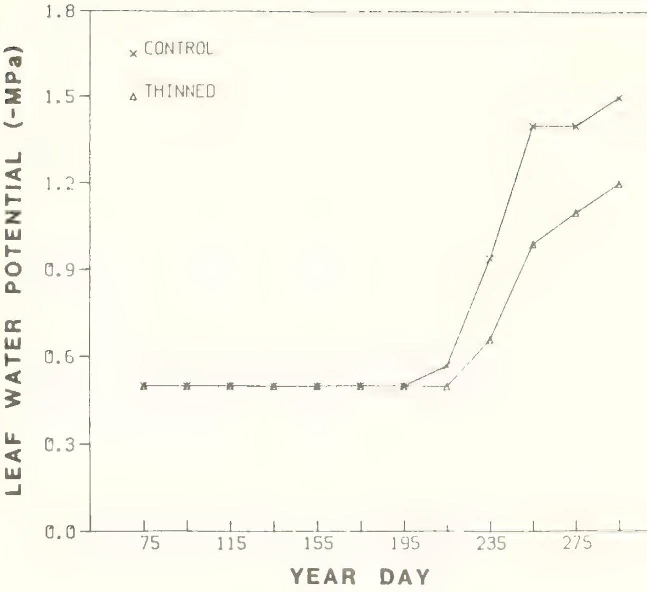

Figure 5--DAYTRANS/PSN simulation of the seasonal trend of predawn leaf water potential for a tree in a thinned versus unthinned stand of lodgepole pine. The thinned stand response was simulated by adding available rooting zone water (20 percent by volume) until the late season water stress was 0.3 MPa lower than in the control stand, calibrating model response to field data, and reducing LAI in the canopy radiation submodel by 50 percent. More negative leaf water potential indicates greater water stress. This calibrated response was then used to predict seasonal photosynthesis differences between thinned and control stands, shown in figure 6.

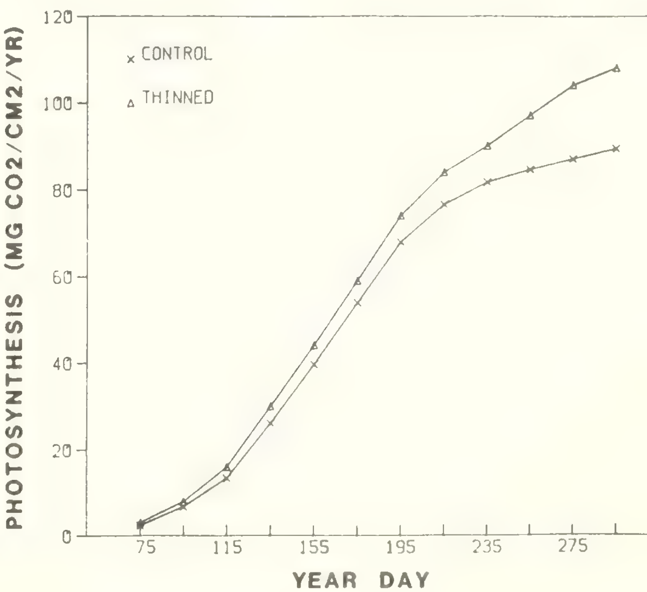

Figure 6--DAYTRANS/PSN simulation of the seasonal photosynthesis for a tree in a thinned versus unthinned stand of lodgepole pine. The thinned stand response was simulated by generating a 0.3 MPa recovery in predawn leaf water potential, which matches the observed field conditions, and reducing LAI by 50 percent in the canopy radiation submodel.

context of a total tree carbon budget as indicated by Agren and others (1980), a 21 percent increase in photosynthate availability may be quite significant, if the majority of additional carbon would go to stem growth. Stem growth is the last priority in carbon allocation by a tree, coming after respiration, root, and canopy growth demands are met. Added photosynthate may very well be allocated primarily to the stem, because other requirements have already been fulfilled. Agren and others estimated from integrating a variety of field data that only 8.5 percent of the annual photosynthate production of a single 14-year-old Scots pine (P. sylvestris) in Sweden was incorporated into stem growth. In their analysis, the most comprehensive tree carbon budget work we are aware of, respiration consumed 10 percent of annual photosynthate, and of greatest surprise, root growth used 57 percent of annual photosynthate.

If little of the predicted 21 percent additional photosynthate from our thinning response was needed by other parts of the tree, then the increase in photosynthate we predict could substantially increase the carbon allocated to stem growth. In reality, remaining trees opportunistically grow roots and crown into previously occupied area. However, the investment in that tissue probably is balanced by the return regained by additional tree leaf area producing even more photosynthate. Also, increased stem growth would require commensurately more growth and maintenance respiration. Hence, our analysis is only legitimate as an "instantaneous" response of the tree to reduced canopy light competition and increased available water supply. However, these predictions match the increases in tree growth efficiency (basal area growth/unit leaf area) found after thinning P. contorta by Waring (1983).

CONCLUSIONS

We think it is important to look at physiological responses when we do silvicultural research. We would also suggest that the new ecosystem simulation models when used correctly can provide some predictive capacity that we haven't had before. The prediction of thinning response reported here is an example of something we can do more often. Ecosystem models can help us predict before the fact, giving us more power to understand the potential consequences of our silvicultural activities.

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PREDICTING RESPONSE OF UNDERSTORY VEGETATION TO STAND TREATMENT: CONSEQUENCES FOR MULTIRESOURCE MANAGEMENT

Roger D. Hungerford

ABSTRACT: The procedure described here for predicting response of understory vegetation to treatment alternatives synthesizes ideas from published research on species survival strategies and growth characteristics. Seedling establishment equations are given for some tall shrubs. Height growth equations for four tall shrub species are also presented. An example of the procedure for three treatment scenarios is discussed to illustrate differences in the developing communities.

INTRODUCTION

Whether the purpose is to grow timber, enhance wildlife, manipulate water yields, enhance recreation, or provide grazing, land managers are in the business of managing vegetation. Silviculturists have spent much time and effort improving tree regeneration, partly by controlling competing vegetation. Wildlife managers concerned about declining populations have focused efforts on manipulating vegetation to provide cover and forage to improve wildlife habitat. A large part of range managers' efforts has focused not only on improving desirable forage plants but also on controlling undesirable plants.

In many cases multiresource management objectives and goals can be compatible, but they can also be competing. Whatever the objective, success or failure in achieving it often depends on knowledge about individual species characteristics. We also need to know how and why plants respond to various kinds of disturbances. And, understanding natural development and succession of plant communities is helpful for understanding how to manipulate the various species in the communities.

A number of regional models for plant succession exist (Arno and others 1985; Irwin and Peek 1979; Potter and others 1979; Stage 1973). Some of these models consider only the tree component (Potter and others 1979; Stage 1973), but submodels of the Prognosis Model (Moeur 1985; Wykoff and others 1982) include understory species occurrence and growth. Morgan and Neuenschwander (1985) give a conceptual model based on some causal factors for the cedar/clintonia (Thuja plicata/Clintonia uniflora) habitat type which describes understory development. Arno and others (1985) describe a classification model based on plant responses for four habitat types in western Montana. Keane (1985) used this to develop a simulation model.

Large acreages of even-aged, small-stem lodgepole pine stands occur in Montana. Many of these stands are old (over 80 years) and need treatment because they are overstocked. Also, large acreages are susceptible to attack by the mountain pine beetle. High mortality over many acres has already created a tremendous fire hazard, with a threat of accelerated mortality in many more stands. In addition, wildlife and watershed values are quite important in many of the stands. A major barrier to timber management in these stands is that the value of the products available is often insufficient to pay for the desired treatments.

Current research is directed toward making treatment of these stands more economical. Higher valued products are being developed, such as roundwood-based truss joists, which could make harvesting of many stands economical. New technologies and concepts for harvesting may also make removal of material more economical. Forwarding systems, walking machines with shears, large brush rakes, swathers, and other equipment could facilitate moving large amounts of materials more cheaply than present systems. Although few of these systems are in operation in our stands today, they are being used in other regions of the Country. If we assume that these or similar technologies may be used in the future, our management options will be greatly expanded.

Although new products and technologies will give us new opportunities, they will also bring new concerns. With new treatments, managers will not have experience in judging site and vegetation consequences. Without the benefit of long-term studies, we must base predictions on our understanding of how biological systems function. Using such knowledge can provide a reasonable basis for understanding how plants respond to disturbance. If vegetation response to a treatment can be predicted with some degree of certainty, then we should be able to evaluate consequences for other resources.

In this paper I propose a procedure for predicting species composition and growth of understory

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Roger D. Hungerford is Research Forester, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT.

vegetation in lodgepole pine stands for 14 habitat types in Montana. The procedure is proposed as a method for evaluating effects on the understory vegetation of alternative stand treatments. The paper discusses the important components of the procedure and specifically deals with 28 species of plants. The procedure is a synthesis of some well-established ecological principles, new analyses of published data, and some existing approaches.

Equations to predict establishment of shrub seedlings of two species and height growth for four shrub species are presented. Tentative equations, based on published results, are also included for predicting biomass of low shrubs and herbs following clearcutting and for different overstory canopy levels. Following description of the procedure, an example is presented that illustates how it might be used to evaluate treatment alternatives. The procedure is presented as a preliminary approach that needs to be tested. The concepts and principles discussed could be used to expand the procedure to include other habitat types and additional species.

THE PROCEDURE

The procedure for predicting vegetation development is outlined in figure 1 and consists of two parts. Part one deals with predicting species composition of the initial plant community and part two with predicting the development rate of that community. To simplify the procedure, the species have been grouped (fig. 1), based on how they contribute to structure of the plant community. Low shrubs and herbs (3 feet or less in height) are typically important for their forage potential and as ground cover. Tall shrubs (more than 3 feet tall) are typically important to wildlife as cover and forage and for visual screening. Trees, including regeneration, are shown as part of the plant community, but are not part of the prediction process discussed here. Tree growth and development are handled adequately using other techniques. Models such as Prognosis (Stage 1973; Wykoff and others 1982) and LPPIM (Cole and Edminster 1985) are suitable and can be used for Montana lodgepole pine.

Information needed to use the procedure consists of site characteristics (habitat type), treatment characteristics (percent surface area disturbed, percent mineral soil exposed, depth of mechanical scarification, depth of lethal heat pulse from burning), vegetation characteristics (percent overstory canopy, pretreatment species, stocking density of tall shrubs), and species survival and colonization strategies. Outputs from the procedure are species composition, stocking density and height for each tall shrub species, and biomass for low shrubs and herbs. Based on average crown widths for tall shrubs, canopy shape is determined and structure of the developing community displayed. Other values such as wildlife hiding cover and visual screening can be derived from these values using other models (Lyon 1987).

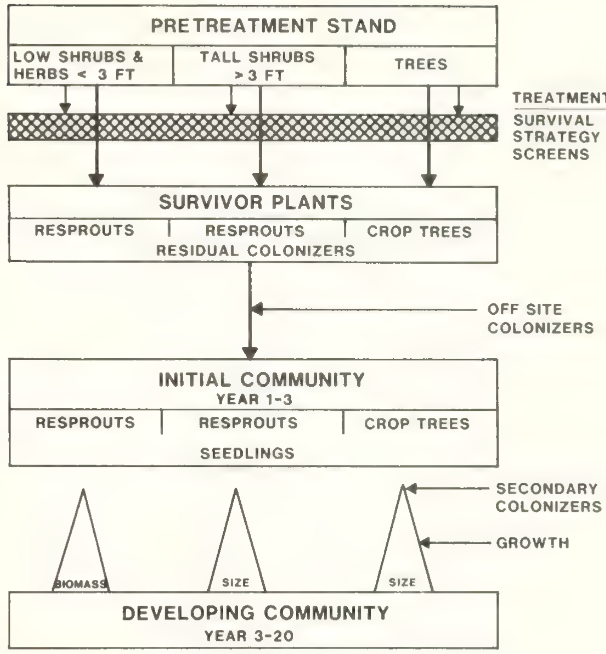

Figure 1--Diagram of procedure for predicting vegetation response on lodgepole sites in Montana in response to treatment. The procedure is keyed to survival and colonizing strategies of the plant species present in the pretreatment stand and adjacent stands.

PREDICTING THE INITIAL COMMUNITY

Two key concepts form the foundation of the first part of the procedure:

1. The majority of plant species that occur after treatment are present before treatment. Thus, if we know the pretreatment species composition we have a good start at predicting the posttreatment composition (Lyon and Stickney 1976; Stickney 1980, 1985, 1986a).

2. Survival and colonization strategies are known for many species. These provide the concepts for describing how species react to disturbances by sprouting, disseminating propagules, and establishing on new sites (Grime 1979; Lyon and Stickney 1976; Noble and Slatyer 1980; Rowe 1983).

Together, these two concepts allow prediction of surviving plants, and the addition of offsite colonizers and secondary colonizers following treatment.

Pretreatment Stand Data Needs

Following the conceptual model of Lyon and Stickney (1976) and Stickney (1986a), the best predictor of posttreatment species composition is the pretreatment species composition. As a minimum, data on species composition are needed for low shrubs and herbs and tall shrubs in the pretreatment stand. For the tall shrubs, a stocking

density is also needed. Data on abundance, such as canopy coverage, for low shrubs and herbs may be useful, but are not necessary.

An exhaustive species list is not needed, but the important species should be recognized. Importance can be based on a number of criteria, such as abundance, special management interest, forage importance, or some other measure. I have listed important species (table 1) based on abundance in habitats dominated by lodgepole. These species are those most likely to be present, based on constancy tables in Pfister and others (1977). Other species may need to be added by the user.

Needed species composition and stocking density data can be obtained using any number of standard sampling procedures (Mueller-Dombois and Ellenberg 1974; Pfister and others 1977; Stickney 1986a). A major concern for the user of this procedure is to select a sampling level with an acceptable error rate.

Using data from the pretreatment stand for the prediction procedure provides the maximum opportunity to select a preferred treatment based on expected vegetation development. However, the procedure can also be used after treatment to predict growth by sampling initial posttreatment vegetation. In either case, one starts the procedure with species composition and density data.

Treatment-Survival Strategy Screens

Species that exist in the pretreatment stand must pass through the treatment-survival strategy screen (fig. 1) to become part of the initial posttreatment community. Two major factors make up the "screen" through which species must pass. This screen determines posttreatment survival and abundance:

1. The type of treatment (fire, harvesting, seedbed preparation, and so forth) determines the depth and areal extent and the severity of disturbance.

2. Species attributes and survival strategy determine how individual species respond to disturbances.

The treatment applied, whether it is fire, harvesting, or both, interacts with the survival strategies of species to determine species survival. To predict what species pass through the screens, it is necessary to know the expected extent and depth of disturbance, values for which can be based on target values managers use in their prescriptions and their judgment based on past experience. The expected extent and depth of disturbance is then coupled with the survival strategy information in table 1 to determine survival for each important species. Because it is unlikely that 100 percent of the surface of any treatment area will be disturbed to the critical depth for most species, survival percentage by species can be evaluated.

A variety of survival strategy mechanisms exists among species common in lodgepole pine stands (table 1). These structures represent either the "bud bank," which allows for resprouting from various structures and depths, or soil- or crown-stored seed banks that are stimulated by treatment. Most of the root crown shrubs, those with rhizomes greater than 5 cm deep, and the geophytes (such as corms and bulbs) will resprout under quite severe conditions. For example, buds capable of resprouting on western serviceberry (scientific names are in appendix A) root crowns and rhizomes are located from the surface to greater than 5 cm below the surface. Thus, unless a treatment rips up the root crown and rhizomes, or provides a lethal heat pulse to greater than 5 cm deep, the plants are likely to survive the disturbance by resprouting. As indicated in table 1, some species (Scouler willow, Sitka alder, and fireweed) not only resprout but also establish from seed. Burns with deep ground char (Ryan and Noste 1985) can reduce sprouting (Rowe 1983), as can deep mechanical disturbances (Antos and Shearer 1980).

Species with soil-stored seeds (residual colonizers) can provide surprises in the initial community because there may not have been any living plants in the pretreatment stand. Seeds of these species may lie dormant for many years. Dormancy can often be broken by heat from fires or solar insolation on newly exposed surfaces. Black elderberry and elk sedge are typical species in the lodgepole type that follow this pattern. If residual colonizer species are present in adjacent disturbed areas, they are likely to be present after disturbance in other stands in the area.

Survivor Plants

Plants of species that make it through the treatment-survival strategy screens, plus the stored seeds (residual colonizers) that germinate and establish seedlings, make up the survivor plant component of the initial community. Some species from the pretreatment stand may be lost and the relative abundance of some species may be reduced. The process output for survivor plants is a species list and a density value for each tall shrub species; for low shrubs and herbs it is a list showing what species have survived.

This intermediate output should be viewed by the user and compared to the desired species composition. If important species are lost, or undesirable species have survived, the proposed treatment or treatments could be adjusted to achieve desired changes in composition. Adjustments in treatment prescriptions that alter percent of surface disturbed to critical depths for the concerned species will change survival. Treatment factors should be selected to maximize survival of the species important to the user, or mortality of unwanted species.

Offsite Colonizers

Seed dispersal from offsite sources is another important source of plants in the initial community (Morgan and Neuenschwander 1985; Stickney

Table 1--Summary of survival strategies, colonizer potential, and life history characteristics for some important understory species occurring in the lodgepole pine types near and east of the Continental Divide in Montana. Sources: Arno and others 1985; Bradley 1984; Fischer and Clayton 1983; Lyon and Stickney 1976; McLean 1969; Mueggler 1965; Pfister and others 1977; Stickney 1986a; Volland and Dell 1981

	Bud bank						Seed bank						
			Rhizomes and roots				Onsite			Offsite			
Plant species	Root crown[1]	Surface stems[2]	Mineral surface[3]	1.5-5 cm	>5 cm	Geophyte	Secondary	Residual Soil	Residual Canopy	Initial Near	Initial Far	Secondary	Age to reproduction
													years
Tall Shrubs													
Rocky Mountain maple	X						X		?			X	5-10
Sitka alder	X				X		X		X			X	5-8
Western serviceberry	X				X		X		?	X		X	7-15
Rusty menziesia	X						X						?
Scouler willow	X										X		?
Black elderberry	X							X					3-5
Low Shrubs and Herbs													
Common juniper							X				X	X	?
Utah honeysuckle	X										X		5-10
Prickly rose	X			?					?		X		3-5?
Baldhip rose	X			?					?		X		3-5
Russet buffaloberry	X				X			?	?				?
Snowberry				X	X			?	?		X		3-5
Globe huckleberry				X	X		X				X	X	10-15
Kinnikinnik		X						?		X			?
Twinflower		X					X			?	?		?
Shiny-leaf spirea				X	X		X			X		?	2-4?
Dwarf huckleberry				X			X				X	?	?
Whortleberry				X			X				X	?	?
Broadleaf arnica				X			X			X		X	1-2
Showy aster				X			X			X		X	1-2
Pinegrass			X	X			X			X		X	1-2
Elk sedge				X			?	X					3-5?
Fireweed				X	X	X	X				X		1-2
Glacier-lily						X	X			?		?	1
Strawberry		X					X				X		1-2
Beargrass			X	X			X			X			4-5?
Wheeler bluegrass				X			X			X		?	1-2?
Sidebells pyrola		X	X								X		?

[1]Somewhat massive structures from surface to several centimeters in depth.
[2]Stolons or stems at litter surface or in duff.
[3]At or near mineral soil surface.

1986a). Seeds of these initial offsite colonizer plants originate in adjacent areas and take advantage of disturbed sites to germinate. Such seeds can be transported to the site by wind, animal, or water vectors, but usually they are small airborne seeds (Lyon and Stickney 1976). The importance of these offsite sources to the initial community varies with the seed availability, environment, topography, and with the condition of the seedbed provided by the treatment. Stickney (1986a) points out that the colonizer component is the most uncertain element in predicting the initial community because of the chance nature of immigration events. But a knowledge of the seed production characteristics and suitability of seedbeds can do much to reduce the uncertainty.

A number of the most abundant species are initial offsite colonizers (table 1), but only a few species (for example, fireweed and Scouler willow) can establish and make a big showing. The classification of species as initial offsite colonizers in table 1 is tentative. Specific information about the seeding habits of these species, particularly under natural conditions, is quite limited. Additional research is needed on seed dissemination and establishment requirements for many species.

For the low shrub and herb group it is probably sufficient, for this procedure, to assume that initial offsite colonizer species are likely to establish following most treatments where mineral soil is exposed. Fireweed, in habitat types where it occurs, is the only species in the low shrub and herb group that is likely to establish abundantly by colonizing from offsite. Others of these species may increase in abundance as surviving plants, set seed, and establish new seedlings. This process of secondary colonization will be discussed later.

Scouler willow is the only one of the tall shrub species in table 1 that functions as an initial offsite colonizer. I use Scouler willow as an example to illustrate an equation for predicting seedling density for an initial offsite colonizer. Scouler willow seeds are very small and short lived (Zasada and others 1983), making establishment very susceptible to weather and seedbed conditions. Seed is dispersed early in the spring (May to July) (Brinkman 1974), requiring a moist mineral soil seedbed for germination. For the habitat types considered in this paper, not much is known about Scouler willow seedling establishment. However, information from Stickney's (1980, 1986a, 1986b) studies in northern Idaho and western Montana can be adapted. In

these studies, seedling establishment and density were observed on permanent plots after burning treatments. At four different study locations the number of seedlings ranged from 0 to 1,300 per acre. The wide range of values for these locations suggests habitat type differences for establishment which may reflect seed production, weather, or site variations.

Predictions of seedling densities are based on the number of seed spots stocked. In this procedure, the number of potential seed spots is based on the average crown diameter measurements of Scouler willow from Stickney's data (1986b). Scouler willow crowns averaged 6.2 feet in width, thus covering 38 ft^2 of surface. If plants are evenly spaced, crown closure would be complete with 1,133 plants (43,560 ÷ 38.44) per acre. Any number of plants above 1,133 (spaced evenly) do not contribute much more to hiding cover, visual aspects, or other similar values; thus, I assume 1,133 potential seed spots per acre. To predict the number of spots stocked, two types of information are required: (1) the percent of potential seed spots with mineral soil exposed, and (2) the probability of any available spot becoming stocked based on habitat type differences.

For the most productive habitat types, I assumed that under normal conditions the probability of stocking potential seed spots with mineral soil exposed is 1.0 (100 percent). Establishment on less productive habitat types will be less than 1.0. Assuming that habitat type integrates site, weather, and seed production differences for establishment, judgments about probability on other habitat types can be made. Table 2 shows the probability values assigned to typical habitat types in the Montana lodgepole region. Values are based on judgment and constancy values for Scouler willow by habitat type (Pfister and others 1977). These values are consistent with density observations made by Stickney (1986b) and Lyon (1971) for comparable habitat types and treatments.

The final equation for determining the number of seed spots (S) stocked is:

$$S = PMq \qquad (1)$$

where P is the potential number of seed spots per acre (1,133), M is the proportion of mineral soil exposure, and q is the habitat probability of any available spot becoming stocked.

Initial Community Composition

Survivor plants and initial offsite colonizers make up the initial community in the first 3 years following treatment. Based on Lyon and Stickney's data (1976), 70 to 86 percent of the plants in this initial community are from onsite sources (either survivors or residual colonizers) and 14 to 30 percent are from offsite seed sources. Sprouting potential for the survivors is not only a function of treatment and survival strategy type, but the age and vitality of individual plants in the undisturbed community (Gill 1977; Naveh 1975). More vigorous shrubs respond better. Although age and vitality are important, I have not included these factors because of the difficulty in aging plants and assessing vigor. Growth data used later include a range of conditions.

Following establishment of the initial community and addition of secondary colonizers that become established, the vegetation proceeds through

Table 2--Probability of seed spots becoming stocked with Scouler willow and Sitka alder, and potential number of plants per acre, by habitat type

Habitat type	Scouler willow		Sitka alder	
	Probability	Number per acre	Probability	Number per acre
PICEA/LIBO	0.18	204	0.7	793
ABLA/CACA	.08	91	.1	113
PSME/LIBO	.14	159	.4	453
ABLA/LIBO-LIBO	.18	204	.5	566
PICO/LIBO	.16	181	.5	566
ABLA/XETE	.12	136	.4	453
ABLA/LIBO-VASC	.09	102	.2	227
ABLA/CARU	.04	45	0	0
PSME/VACA	.06	68	0	0
ABLA/VACA	.12	136	0	0
PICO/VACA	.01	11	0	0
PSME/CARU	.01	11	.1	113
PSME/JUCO	.01	11	0	0
PICO/VASC	.02	23	.3	340
ABLA/VASC-VASC	.02	23	.3	340
TSHE/CLUN[1]	.40	453	1.0	1,133
ABLA/CLUN[1]	.14	159	.6	680
PSME/PHMA[1]	.01	11	0	0

[1]Habitat types sampled by Stickney (1986b).

annual iterations of development and mortality of these initial species.

Secondary Colonizers

Once the initial community is established, species called "secondary colonizers" continue to be added at a slow rate. The source for these plants can be onsite or offsite, and, although these species are a minor component (22 percent in Stickney 1986a), they are often important contributors to the community. Seedlings of these species must be capable of establishing in closed or partially closed communites. Although these characteristics are often attributed to climax species, some important seral plants also function this way.

The classification of species as secondary onsite and offsite colonizers in table 1 is based on limited available literature and observations (Stickney 1986b). Many of these species are known to function as secondary colonizers, but seedbed and environmental requirements need investigation. The potential for increasing in abundance needs further quantification.

For low shrubs and herbs, increases in abundance of secondary colonizer species will be included in the section on low shrubs and herb development. Some species (showy aster, broadleaf arnica, pinegrass, and fireweed) increase dramatically in abundance after some treatments (Fischer and Clayton 1983; Stickney 1986b). For the tall shrubs in table 1, all but Scouler willow seem to operate as secondary colonizers; however, Sitka alder is the only species that increases rapidly in density. Stickney (1986b) has observed colonizing seedlings of western serviceberry and Rocky Mountain maple, but their numbers are few and they grow slowly. I use Sitka alder as an example to illustrate an equation for predicting seedling density for a secondary colonizer.

Sitka alder functions as a secondary colonizer, in addition to a survivor, and over time greatly increases its density on a site. Sitka alder seed is not dispersed long distances, but most often falls within a 30-foot radius of the parent plant (Stickney 1986b). Surviving Sitka alder plants begin to flower and set seed from years 5 through 8. Often large numbers of seedlings become established about 8 years following a burn or other treatment. Apparently moss layers and litter from other vegetation do not inhibit establishment (Stickney 1986b), but the numbers of new seedlings decline after year 12.

Predictions of expected Sitka alder seedling densities can be made in a manner similar to that described for Scouler willow. I have assumed (1) the same number of potential stocking spots (1,133 per acre) based on a 6.2-foot crown width for the plants, (2) the probability of any available spot becoming stocked is based on habitat type, and (3) number and clumpiness of the surviving plants determine the potential stocking spots that seeds can be dispersed on. Habitat type probability coefficients in table 2 are assigned in the same manner as for Scouler willow.

Dealing with the clumpiness of the surviving plants adds some complexity. Assuming the seedfall around a surviving plant occurs in a 60- by 60-foot area, the influenced area is 3,600 ft^2. On an acre basis: 43,560 (ft^2) ÷ 3,600 (ft^2) = 12; thus 12 evenly spaced plants could potentially stock an acre (all 1,133 potential stocking spots). Each plant could potentially stock 94 stocking spots (1,133 ÷ 12).

The problem is that rarely will these plants be evenly spaced, so some measure is needed to determine the number of potential stocking spots influenced by the distribution of surviving plants. A key measurement needed for the surviving plants is the average distance between individuals. Given this measurement, one equation for three cases can be used to calculate the number of seed spots (S) expected to be stocked. The equation is:

$$S = NpMq \tag{2}$$

where N is the number of 60- by 60-foot spots per acre occupied by survivors as determined below; p is the number of potential spots that could be stocked by one surviving plant; M is the proportion of mineral soil exposed by treatment; and q is the habitat type probability of any available spot becoming stocked.

When the number of survivors per acre (n) is less than or equal to 12, N is given by:

$$N = n \frac{(\bar{D}_M)}{(60)} \quad \text{for: } \bar{D}_M \leq 60 \tag{3}$$

$$N = n \quad \text{for: } \bar{D}_M > 60 \tag{4}$$

and when n is more than 12, N is given by:

$$N = \frac{\bar{D}_M}{\bar{D}_E} \tag{5}$$

$\bar{D}_M$ is the mean distance between surviving plants and D_E is the mean expected distance between plants assuming an even distribution and given a plot area of 1 acre. $\bar{D}_E$ is calculated by:

$$\bar{D}_E = \frac{43,560}{n} \tag{6}$$

Tests of these equations, based on hypothetical placements of survivors, showed that the results are at least reasonable. The equations provide one way to estimate the density and location of Sitka alder seedlings.

GROWTH OF THE INITIAL COMMUNITY

The developing community from succession years 3 through 20 is determined by growth of plants in the initial community and secondary colonizers. The aggregation of low shrubs and herbs, tall shrubs, and trees determines the structure of this developing community over time. It is the structure and biomass that to a large degree determine the value of the community for the variety of resource uses typically demanded of lodgepole stands. In this prediction procedure, growth of tall shrubs is expressed as height and crown development by individual species, while growth of low shrubs and herbs is expressed as biomass. These two groups will be discussed separately.

Tall Shrub Development

Stickney's data (1980, 1985, 1986b) provide the best opportunity to describe height development for Scouler willow, Sitka alder, western serviceberry, and Rocky Mountain maple. These data track height development for up to 18 years following wildfire or clearcutting and burning at five locations in northern Idaho and western Montana. Height growth equations resulting from other studies (Irwin and Peek 1979; Laursen 1984) are based on one-time sampling of many sites at different successional stages. Because the data indicate that resprouts and seedlings have different growth patterns, they will be discussed separately.

Shrub Resprouts--Observed growth patterns suggested that the data may fit the function described by the equation:

$$H = a(1-e^{-bt}) \qquad (7)$$

where H is the height in meters, t is the number of years since disturbance, and a and b are coefficients.

Stickney's data were used in a curvilinear regression routine to obtain the least squares fit giving the best estimates for a and b. Two separate relationships were fitted: (1) potential height growth was evaluated using observations with no obvious height growth reduction due to snag falls, snow damage, browsing, and so forth; (2) average height growth was evaluated by including measurements with observed height damage.

Height growth is influenced by a variety of factors such as genetic capability, competition with other plants, mode of reproduction, site characteristics, weather, shade, time and others (Irwin and Peek 1979; Laursen 1984; Morgan and Neuenschwander 1985). These need to be accounted for in the equations. In the equation form given above, the coefficient a describes the asymptote of the curve, or the maximum height approached and b represents the growth rate, or the rate at which the maximum height is approached. Factors potentially influencing coefficient a and b include:

1. Genetic capability
2. Site characteristics that influence site capability
3. Overstory shading
4. Competition with other plants
5. Weather.

Some of these factors are easily represented, such as genetic potential which is represented by height of the tallest plants. Site characteristics and weather as they influence maximum height and growth rate are easily understood, but hard to assign values. I have chosen to use habitat types to represent site capability and weather effects on a and b because in theory habitat types integrate these factors. The concept of shade tolerance is well accepted and easy to understand, but not so easily quantified. Data are lacking to determine the effects of shade on the four shrub species considered here; thus, I use separate equations, one to describe a level of 80 percent overstory canopy and another to describe height growth in full sun. Any future data on shade effects could be used to develop an equation for shade, thus replacing the one level used here. Competition is also an easily understood concept, but it is difficult to quantify. In the equations that follow, I have assumed that typical levels of competition are represented in the data, eliminating the necessity to treat it as a variable. The resulting expanded equation form for resprout shrub height growth is:

$$H = gh(1-e^{-bht}) \qquad (8)$$

where g is the genetic height potential and h is the habitat type correction for site.

The habitat type corrections for height growth development are shown in table 3. Corrections were chosen to represent site capability and climate, as these factors influence growth. Data on elevational ranges, precipitation, and temperature (Pfister and others 1977) were also considered when assigning the values for h to each habitat type. All values were benchmarked to the better sites studied by Stickney (1980, 1985, 1986b), ranging from 0 to 1.0, with 1.0 representing the best sites. Figure 2 shows how habitat type is expected to influence height growth rate and maximum height for Scouler willow resprouts. Rocky Mountain maple and western serviceberry are expected to follow a similar pattern. Sitka alder, however (table 3), does not seem to be influenced by habitat type. Sitka alder height growth data from TSHE/CLUN to ABLA/VASC (Lyon 1976, 1984; Stickney 1985, 1986b) show no differences between the two types. One might expect that on some habitat types growth should be slower, but evidence is lacking to verify that assumption.

Equations 7 and 8 and the coefficients for a and h shown in tables 3, 4, and 5 can be applied to typical Montana lodgepole sites. The coefficients given for a can be considered as the maximum potential height for these species. If the user has a better value for maximum height or one that is more realistic for the specific site, it can be substituted for the table values to calculate height growth.

Table 3--Height growth coefficients for tall shrubs by habitat type

Habitat type	Height growth coefficient[1] SASC	ALSI	AMAL[2]	ACGL[3]
PICEA/LIBO	1.0	1.0	1.0	1.0
ABLA/CACA	1.0	1.0	[4]--	--
PSME/LIBO-CARU	.9	1.0	1.0	1.0
ABLA/LIBO-LIBO	.9	1.0	.9	1.0
PICO/LIBO	.9	1.0	.9	.9
ABLA/XETE-VAGL	.8	1.0	.8	.9
ABLA/LIBO-VASC	.8	1.0	.8	--
ABLA/CARU	.8	--	.6	--
PSME/VACA	.7	--	.9	--
ABLA/VACA	.7	--	.8	--
PICO/VACA	.7	--	.8	--
PSME/CARU	.7	1.0	.8	.7
PSME/JUCO	.6	--	--	.7
PICO/VASC	.5	1.0	.5	--
ABLA/VASC-VASC[5]	.5	1.0	.5	--
TSHE/CLUN-CLUN[5]	1.0	1.0	1.0	1.0
ABLA/CLUN-CLUN[5]	1.0	1.0	1.0	1.0
PSME/PHMA-PHMA[5]	1.0	--	1.0	1.0

[1]Coefficient to adjust height based on habitat type is applied to both coefficients in the height growth equation for resprouts and to the a coefficient for the seedling height growth equation.

[2]Coefficient is based on elevational gradient of habitat types, as suggested by Mueggler (1965).

[3]Coefficient is based on elevational gradient, as suggested by Laursen (1984).

[4]Species not likely to be present in these habitat types.

[5]Equations developed from data on these habitat types.

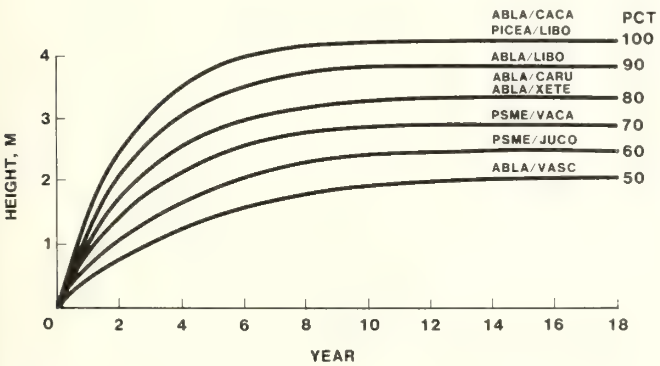

Figure 2--Habitat type effects on height growth are shown for Scouler willow for several habitat types. Reductions in height by habitat type are relative to growth for the best sites. The effect is similar for the other tall shrub species.

Results of the analysis to fit Stickney's data to the equation and evaluate the coefficients for a general fit to all sites are given in table 4. Based on r^2 and standard error of estimate values, the equation seems to represent height growth over all sites combined rather well. Figures 3A and 3B illustrate the least squares equation fit and actual data points describing potential and average growth of Rocky Mountain maple. Plots for other species are not shown, but are similar.

Coefficients for the equations describing growth under an 80 percent canopy (table 4) are all based on a few Scouler willow shrub resprouts in a dense lodgepole pine stand. These shrubs were dissected to determine age and annual height growth increments under an overstory. Growth measurements were then used to develop curvilinear regression coefficients. The reduction observed for Scouler willow growth in the shade compared to full sun was used to adjust full sun coefficients to the 80 percent canopy condition for the other three species. Figure 4 shows the height growth curves for all four species over a 16- to 18-year period following treatment. Potential, average, and shaded site curves are shown where appropriate.

Shrub Seedlings--Seedling establishment and growth is important for Scouler willow and Sitka alder, but is not a major contributor toward community development in the first 20 years for Rocky Mountain maple or western serviceberry. The procedure I followed for developing growth equations for Scouler willow and Sitka alder was the same as for the resprouts. Height growth patterns for these two species were found to follow a function of the form:

$$H = \frac{a}{1+be^{-ct}} \tag{9}$$

where H is height in meters, t is time since treatment and a, b, and c are coefficients.

Seedling height data (Stickney 1986b) were used to develop curvilinear regression coefficients. The coefficients for this equation are not as easily assigned biological meaning, but a represents the maximum height or genetic potential (g), as in equations 7 and 8. Both b and c influence the rate at which height growth approaches the maximum value. Habitat type correction for height growth can be made by adjusting the coefficient a and the equation becomes:

$$H = \frac{gh}{1+be^{-ct}} \tag{10}$$

where h is the habitat type correction coefficient and g is the genetic potential.

Height reductions were observed for seedlings, as they were for resprouts; therefore, I developed potential and average equations for both species. In addition, I developed an equation for dense seedlings of Scouler willow where 1,300 seedlings per acre were present. This situation represents a high degree of competition (fig. 4).

Coefficients from the analyses are shown in table 5. Good fits to this equation form are indicated by the r^2 values and the standard errors of estimate. Equations 9 and 10 seem to

Table 4--Coefficients for resprout height growth equations for four tall shrubs under different canopy conditions--potential and average growth

Species and overstory	Potential a	b	r^2	SEE	Average a	b	r^2	SEE
	Equation coefficients[1]							
Willow (SASC)								
No canopy	4.3	0.45	0.80	0.25	3.5	0.45	0.79	0.32
80 percent canopy	3.5	.15	.99	.05	2.3	.16	.98	.09
Serviceberry (AMAL)								
No canopy	3.2	.26	.84	.22	2.6	.33	.72	.27
80 percent canopy	2.6	.08	--	--	2.6	.08	--	--
Alder (ALSI)								
No canopy	4.5	.26	.92	.24	4.5	.10	.84	.33
80 percent canopy	3.6	.08	--	--	3.6	.08	--	--
Maple (ACGL)								
No canopy	4.6	.16	.83	.35	2.9	.17	.72	.27
80 percent canopy	4.6	.08	--	--	2.9	.08	--	--

[1]Equation form: $Y = a(1-e^{-bt}) = Y = gh(1-e^{-bht})$;

(h = habitat coefficient; g = genetic potential).

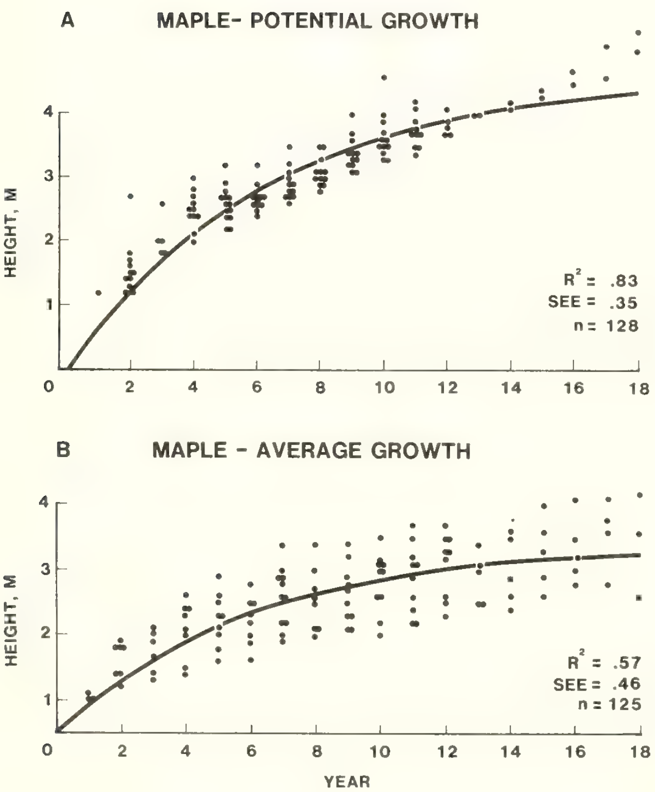

Figure 3--Equation fits for height growth of Rocky Mountain maple. (A) Curve is the least squares fit to the plotted data points for the potential height growth. (B) Curve is the least squares fit to the plotted data points for the average height growth. The number of observations and the equation statistics are given for both situations.

describe the growth patterns for Scouler willow and Sitka alder seedlings quite well. Growth, from the time of establishment, is initially slow (fig. 4). This initial period would seem to coincide with the period of root development. Growth rate increases after 4 to 6 years, with maximum heights approaching the height of resprouts by 16 to 18 years. Where Scouler willow seedlings were dense, growth rate was slower. Yet, eventually, maximum heights equivalent to resprouts may be reached, if plants are not shaded out first.

Height Growth Comparisons--Height predictions from Irwin and Peek's (1979) and Laursen's (1984) equations are compared in figure 5 with those presented here. I adjusted the variables to fit the conditions of Stickney's sites and represent the conditions Laursen used for total cover and stand basal area values. The treatment simulated for these runs was a clearcut and a burn. Laursen's equations for average height growth predict shorter plants, except for Rocky Mountain maple, than do my average height equations until about years 13 to 15 when the values are equal (Sitka alder excepted). For Rocky Mountain maple, Laursen's equations predict heights similar to my potential growth equation. In the case of Scouler willow, Sitka alder, and western serviceberry, Laursen's growth curves are much more linear over the growth period than my curves; thus, my equations predict much more rapid initial height growth.

Compared to Irwin and Peek's equations, equations developed here predict taller western serviceberry, shorter Scouler willow, and equal Rocky Mountain maple heights for average plants. The shape of the curves, with more rapid initial growth, is comparable.

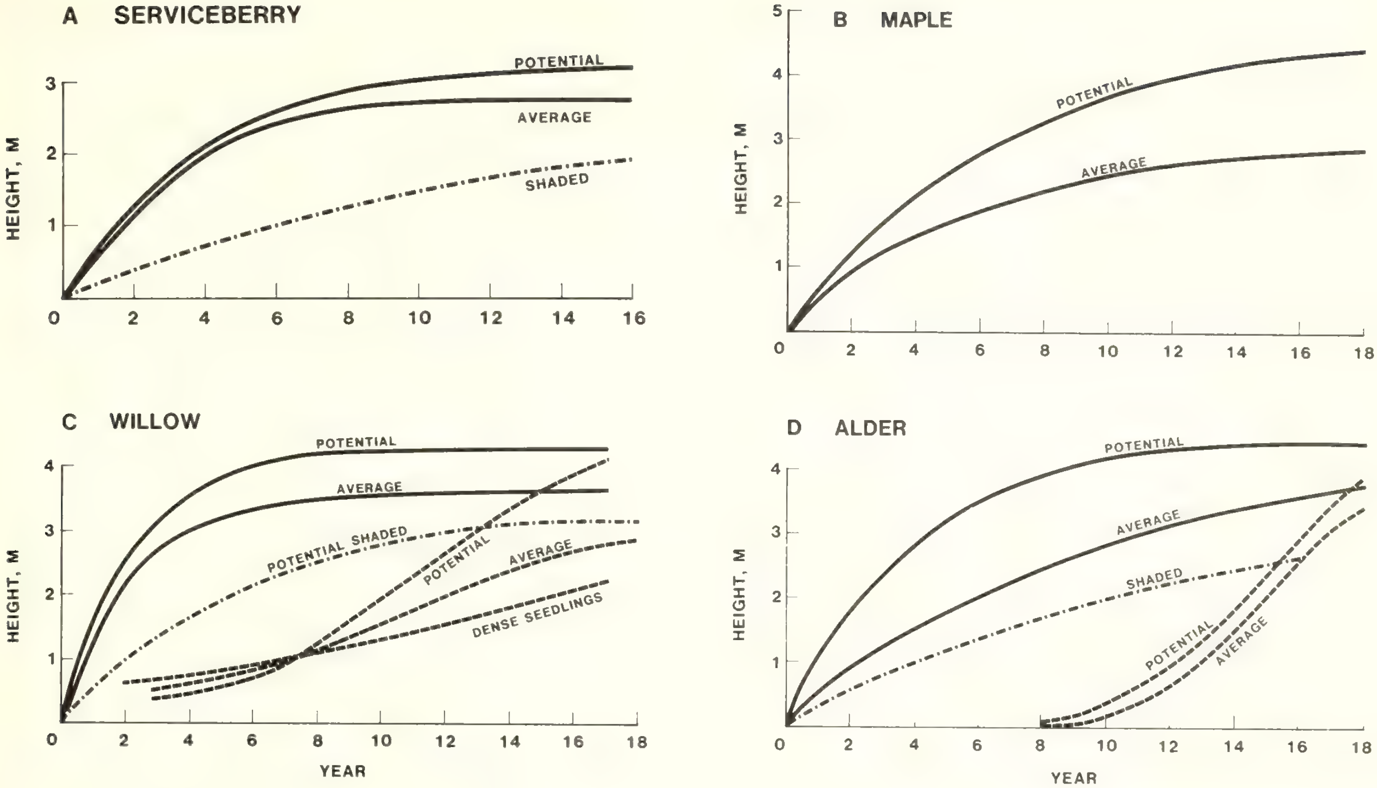

Figure 4--Height growth curves for western serviceberry (A), Rocky Mountain maple (B), Scouler willow (C), and Sitka alder (D). Curves are shown for potential and average growth in full sun and under shade for some species. Seedling growth curves are shown for willow and alder.

Table 5--Coefficients for seedling height growth equations for Scouler willow and Sitka alder--potential and average growth

Species and overstory	Equation coefficients[1]									
	Potential					Average				
	a	b	c	r^2	SEE	a	b	c	r^2	SEE
Willow (SASC)										
No canopy	4.7	33.7	0.31	0.97	0.16	3.4	14.0	0.24	0.82	0.30
Dense seedlings	5.2	11.7	.13	.95	.17	3.6	6.1	.08	.82	.13
Alder (ALSI)										
No canopy	4.9	23.4	.44	.98	.16	3.9	38.0	.54	.89	.33
Serviceberry (AMAL)	- - - - - - Less than 0.5 m tall in 18 years - - - - - - -									
Maple (ACGL)	- - - - - - Less than 0.5 m tall in 18 years - - - - - - -									

[1] Equation form: $Y = \frac{a}{1+be^{-ct}} = \frac{gh}{1+be^{-ct}}$

(h = habitat coefficient; g = genetic potential).

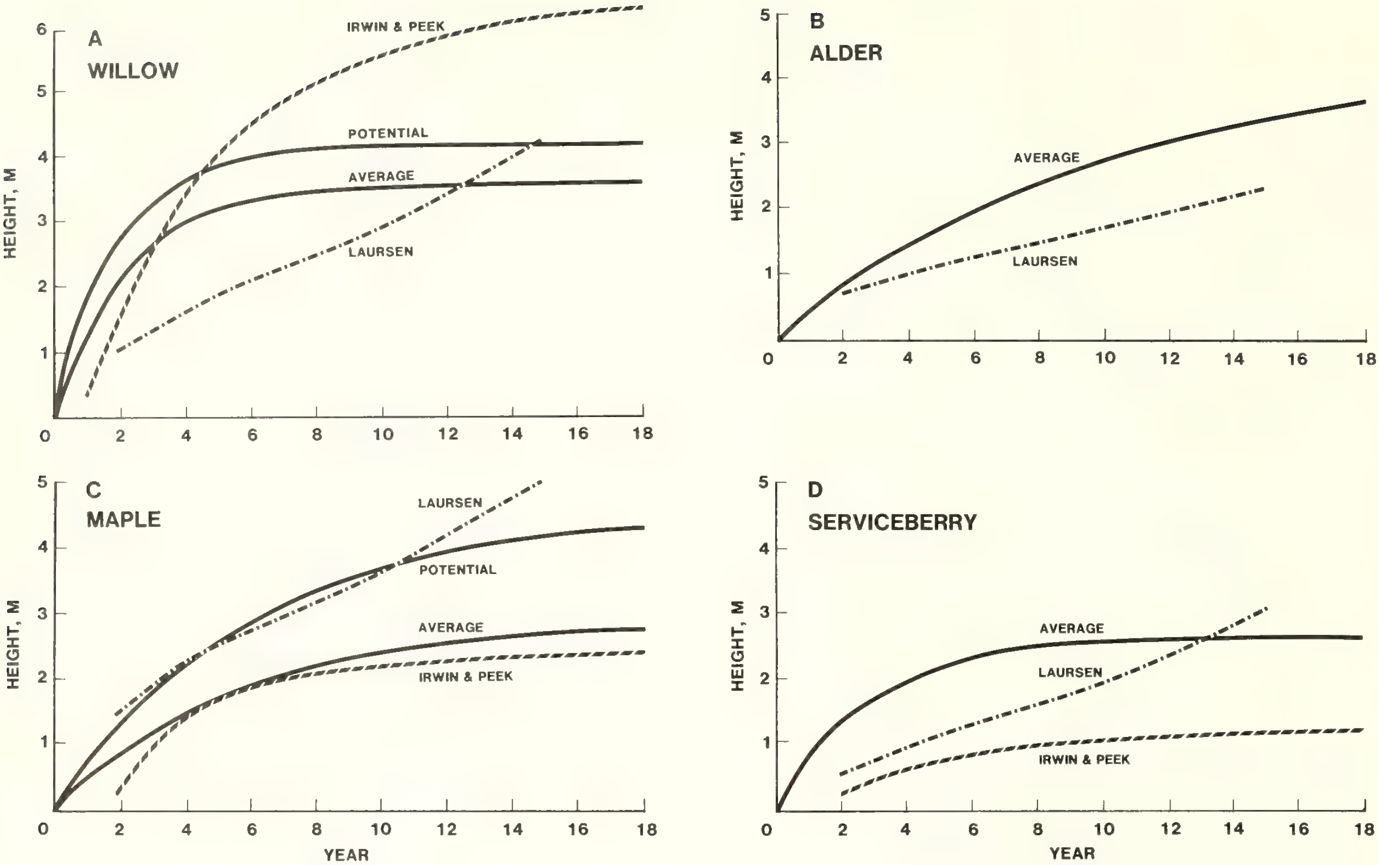

Figure 5--Comparisons of height growth equations reported here for the four tall shrub species with those reported by Laursen (1984) and Irwin and Peek (1979).

A major difference between these published height predictions and those presented here is the difference in model forms. Laursen and Irwin and Peek used lognormal linear regression models, while I used variations of an exponential model. Laursen's and Irwin and Peek's data also included resprout and seedling growth, which have different development rates. Clearcut and burn or wildfire treatment severity and stand history variation for Laursen's and Irwin and Peek's data are much greater than for Stickney's sites. This added variation, at least in Laursen's data, may explain why the r^2 values for his equations are from 0.18 to 0.35, as compared to 0.72 to 0.93 (tables 4 and 5) for my equations. Variation associated with data for stands to 70 years of age is also included in Laursen's work.

Low Shrubs and Herb Development

A number of studies have shown that understory herbage production increases dramatically after removing the lodgepole pine overstory (Basile and Jensen 1971; Trappe and Harris 1958). Other studies (Austin and Urness 1982; Conway 1982; Dodd and others 1972) demonstrate that herbaceous biomass production is inversely related to the amount of lodgepole pine overstory. The relationship in British Columbia (Dodd and others 1972) was strong enough that herbage production could be estimated by measuring tree canopy cover on aerial photographs.

Although the amount of light that reaches the forest floor is inversely related to the amount of overstory canopy, the primary effect of the overstory on understory biomass is due to reduced moisture rather than to light (Tisdale and McLean 1957). Donner and Running (1986) determined that water stress in lodgepole pine was directly related to the residual basal area and thus overstory canopy coverage. They sampled stands thinned to several densities.

The range of maximum understory productivities following clearcutting is not great in Montana lodgepole stands, ranging from 800 to 1,000 pounds annually per acre, and occurring about 11 years after cutting (Basile and Jensen 1971). Basile (1975) showed that moisture and available potassium in the soil significantly influenced productivity. Some personal observations indicate that severe scarification can delay the time to peak productivity. In wide-spaced thinnings (18 by 18 feet) in 10- to 15-year old stands, maximum productivity may extend to 30 years after clearcutting (Conway 1982). These maximum levels of productivity may be obtained in older stands that are thinned, if the residual overstory canopy coverages are low.

Given the present state of knowledge, the work of Basile and Jensen (1971) provides the best basis for predicting understory biomass development following clearcutting of lodgepole stands in Montana. For this procedure, a curve (fig. 6) was derived using their data, with time since

cutting as the only independent variable. Predictions of biomass can be made directly from this figure.

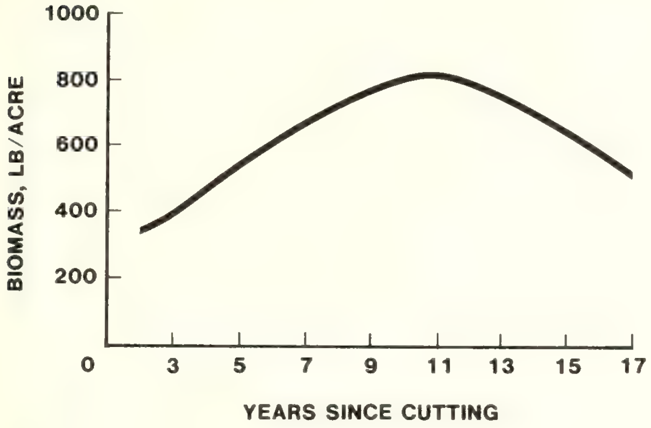

Figure 6--Biomass production of forbs and grasses over time following clearcutting and site preparation in lodgepole stands in Montana (from Basile and Jensen 1971).

Where partial cutting or thinning treatments are imposed, biomass predictions can be made using the equation:

$$\text{Biomass } \frac{(\text{pound})}{\text{acre}} = 0.89(874 - 7.76X) \qquad (11)$$

where X is the tree canopy cover in percent.

This equation was derived from Conway (1982) by using his data from the Gallatin and Lewis and Clark National Forests. An r^2 of 0.66 indicates a relatively strong relationship between dependent and independent variables. Figure 7 illustrates the equation fit to the data points.

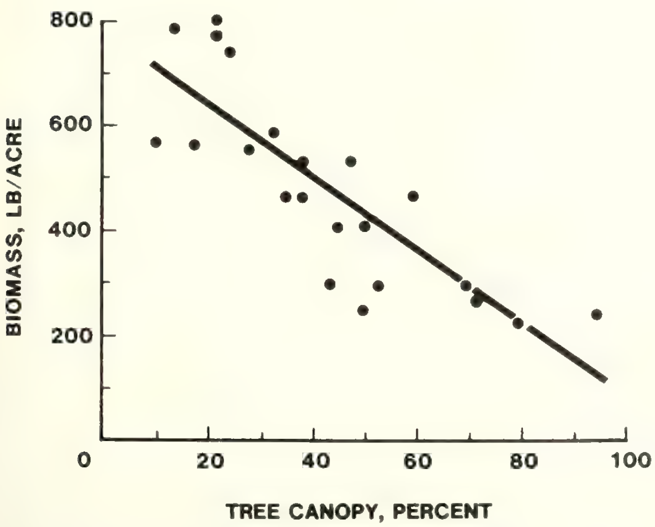

Figure 7--The relationship between percent tree canopy cover and understory biomass production (adapted from Conway 1982).

AN EXAMPLE OF APPLYING THE PREDICTION PROCEDURE

This section summarizes the data needed to use the prediction procedure, and illustrates the predicted understory growth consequences of three treatment scenarios.

Data Needed

Table 6 summarizes the data needed to use the prediction procedure, and indicates potential sources for the data. Table 6 applies to the 28 species discussed in this paper and to the habitat types included in tables 2 and 3. Values for other species and habitat types would have to be generated from the literature and expert judgment.

Comparison of Three Scenarios

Expected community structure, as influenced by treatment and survival strategy, will be illustrated by using a specific stand with three treatment scenarios: (1) a clearcut with burning for site preparation, (2) a thinning that removes 50 percent of the basal area, and (3) a clearcut with bulldozer scarification for seedbed preparation.

Site Description--The site used for this example is an 88-year-old lodgepole pine stand in the Deerlodge National Forest near Georgetown Lake, MT. Elevation is 6,700 feet on a 20 percent northwest-facing aspect. Before treatment the stand was stocked with 6,000+ live stems per acre that averaged 2.5 inches in diameter and 40 feet in height. Habitat type is PSME/LIBO-CARU; mean annual precipitation is about 18 inches.

Pretreatment inventory of low shrub and herb coverage and tall shrub spacing and cover are shown in table 7. Densities for Sitka alder (90 per acre) and Scouler willow (16 per acre) are average values for the stand. Plants are actually clumped with much higher densities (up to 1,500 per acre) in some parts of the stand. To illustrate the procedure I assume the plants are randomly but evenly distributed at the average spacing (fig. 8) to describe community development for the three treatment scenarios. Figure 8 shows an aerial view of the spacing and the plot area to be shown in the following figures. The observer is located 50 feet from the stand edge and 10 feet above the ground surface.

Clearcut With Broadcast Burn--For this example, I assume that the burn (following cutting) consumed all the aboveground vegetation and consumed the duff so that about 50 percent of the mineral soil is exposed. The depth of lethal heat penetration is expected to be about 1 cm. For purposes of simplification I will only project development for the species shown in table 7. In reality many other species may be of interest even though the species in table 7 will provide the major impact. Tree regeneration is important from the standpoint of the future stand and its impact on the understory species, but I have not included tree regeneration in these examples.

Table 6--Summary of data and sources needed for the procedure to predict understory vegetation response to treatment

Data needed	Source
	Plant Data
Species composition	Sampling of pretreatment stand to identify important species
Tall shrub density	Sampling of pretreatment stand to determine number per acre
Tall shrub clumpiness	Sampling of pretreatment stand to determine average distance between individuals
Species survival strategy	Table 1 for 28 species
Seedling establishment probability (tall shrubs)	Table 2 for Scouler willow and Sitka alder by habitat type
Potential height (tall shrubs)	Table 4 for resprouts; table 5 for seedlings. Values are based on curve fitting
Site correction (tall shrub height)	Table 3 for Scouler willow, Sitka alder, Rocky Mountain maple, and western serviceberry. Values based on expert judgment
Overstory canopy (percent)	Values based on prescription targets and later values from growth models (Prognosis or LPPIM)
	Treatment Data
Surface disturbance (areal extent)	Supplied by the user; based on expected treatment disturbance (percent of surface)
Depth of disturbance	Supplied by user; based on expected treatment disturbance (depth for area disturbed to establish mechanical or lethal heat penetration)
Mineral soil exposed (percent)	Supplied by user; based on treatment target for prescription
	Site Data
Habitat type	User-supplied for specific site

Table 7--Primary plant species spacings and ground coverage for an 88-year-old lodgepole pine stand (Echo Lake) in the Deerlodge National Forest

Species	Spacing	Density	Coverage
	Feet	No./acre	Percent
Tall Shrubs			
Scouler willow	52	16	1
Sitka alder	22	90	10
Low Shrubs and Herbs			
Rusty menziesia	--	--	T
Shiny-leaf spirea	--	--	T
Globe huckleberry	--	--	2
Whortleberry	--	--	13
Broadleaf arnica	--	--	40
Showy aster	--	--	T
Pinegrass	--	--	T
Fireweed	--	--	T
Rattlesnake-plantain	--	--	T
Twinflower	--	--	3
Sidebells pyrola	--	--	T

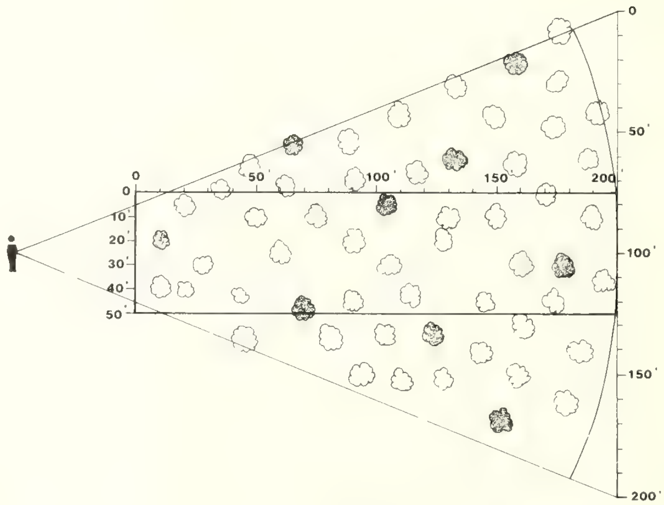

Figure 8--Aerial view of survivor shrub spacing in the example stand used in the three treatment scenarios. The location of the observer and the field of view used in the developing community diagrams is shown. The open diagrams represent Sitka alder and the shaded ones represent Scouler willow.

Scouler willow and Sitka alder have root crown structures (table 1). These are fairly massive structures and are expected to resprout. Dwarf huckleberry and shiny-leaf spirea have rhizomes located from 1.5 to 5 cm or more in depth. These rhizomes will also survive this treatment and resprout. Most forbs and grasses listed in table 6 will also survive and be present in the

initial posttreatment community. Twinflower and sidebells pyrola coverage will be reduced significantly by burning, because the points of sprouting will be consumed, at least on the 50 percent of the area where mineral soil is exposed. Figure 8 shows the expected density of the surviving tall shrubs. Relative spacing is the same as in the pretreatment stand.

Figure 9A shows how the shrubs are expected to look on this site 2 years following treatment. The spacing reflects a 5 percent mortality for Scouler willow and Sitka alder. This level of mortality is assumed, based on Stickney (1980, 1985, 1986a) and Lyon (1971), where very little mortality was noted after burning. Expected seedling establishment for Scouler willow (79 spots stocked per acre) is shown based on the 50 percent mineral soil exposed and habitat correction (table 2) put into equation 1 for Scouler willow seedling establishment. Equations 8 and 10 were used to project height development of resprouts and seedlings. Values for the potential height coefficients for no canopy in tables 4 and 5 were plugged into the equations. The habitat type correction for height growth is obtained from table 3. Crown shape is stylized for these species with width from height-width ratios developed from Stickney's (1986b) measurements.

Using the growth equations for the shrubs, Scouler willow and Sitka alder resprouts are shown to grow rapidly. Growth rates will result in these shrubs appearing as in figure 9B in year 6. Scouler willow and Sitka alder resprouts will be up to 12 feet tall. New Scouler willow seedlings are shown at 2 feet tall and at 23-foot spacings. New seedlings of Sitka alder (225 spots stocked per acre) will become established about year 8 in the vicinity of the parent plants. Equations 5 and 6 are used to calculate N and input into equation 2 to calculate the number of potential spots stocked. By year 20 (fig. 9C) the shrubs are approaching their maximum heights for the site, with Scouler willow at 13 feet and Sitka alder at 15 feet. Scouler willow and Sitka alder seedlings have grown to equal heights of resprouts. Figure 9D shows the appearance if no seedlings had become established. Tree regeneration, if stocking was adequate, would be nearly 15 feet tall and influencing development of the shrubs. It will be important to model the effects of varying levels of tree regeneration in the future.

Biomass of low shrubs and herbs is obtained from figure 6. Ground layer vegetation (which is primarily broadleaf arnica, pinegrass, and twinflower) will produce about 500 pounds per acre annually at 5 years, will peak at 800 pounds per acre at 10 years, and will decrease to pretreatment levels of 300 pounds per acre at 20 years.

Thinning--Removing 50 percent of the basal area of this stand, by thinning from below, will result in a stand with 1,000 trees per acre and a basal area of 110 feet per acre, and a 50 percent canopy. Thinning will cause much less surface disturbance than the clearcut treatment. Most of the aboveground parts of the understory will be

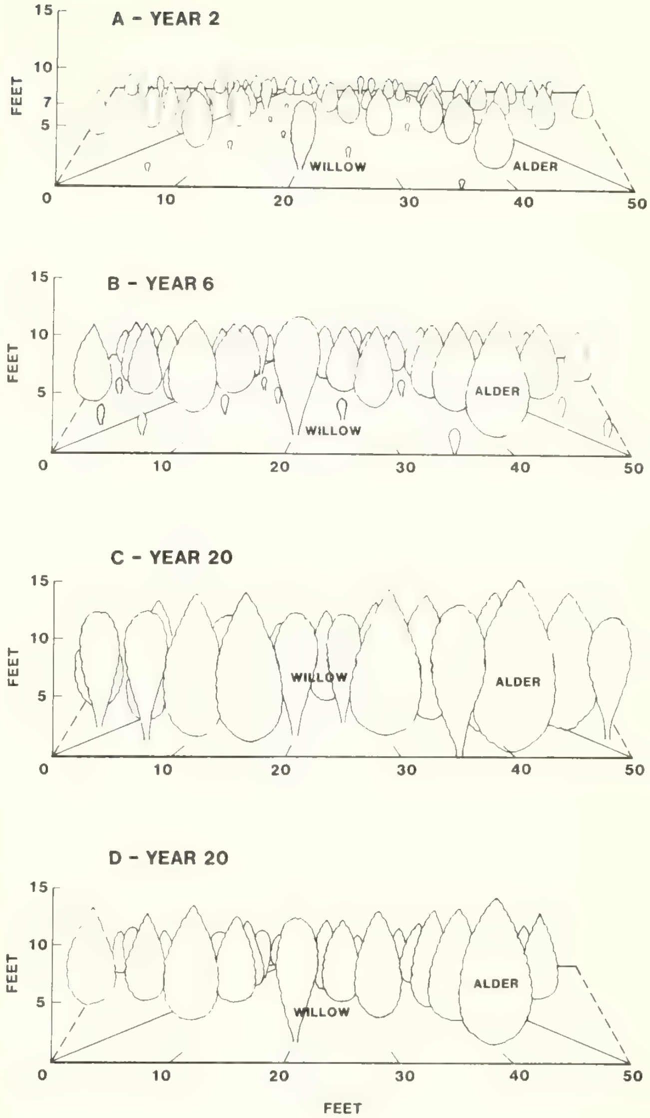

Figure 9--Heights and density of Scouler willow and Sitka alder as they are expected to appear following clearcutting in year 2 (A), year 6 (B), and year 20 (C). Seedlings of Scouler willow and Sitka alder are shown as they are expected to be in A, B, and C. Year 20 is shown without seedlings in D.

cut off or damaged during treatment. Because the underground parts of the plants are essentially undisturbed, almost all plants are assumed to survive the treatment. Sprouting will be stimulated, but the response will not be as rapid as in the clearcut example. Shrub density in year 2 will appear as in figure 10A. Growth response, as calculated for the clearcut and burn example but using the coefficients in table 4 for the 80 percent canopy, will be slower due to the presence of the residual tree canopy that uses the moisture and provides shade. This will result in an appearance by year 6, as shown in figure 10B. Shrubs are much shorter than following clearcutting (Scouler willow 6 feet and Sitka alder 4.5 feet).

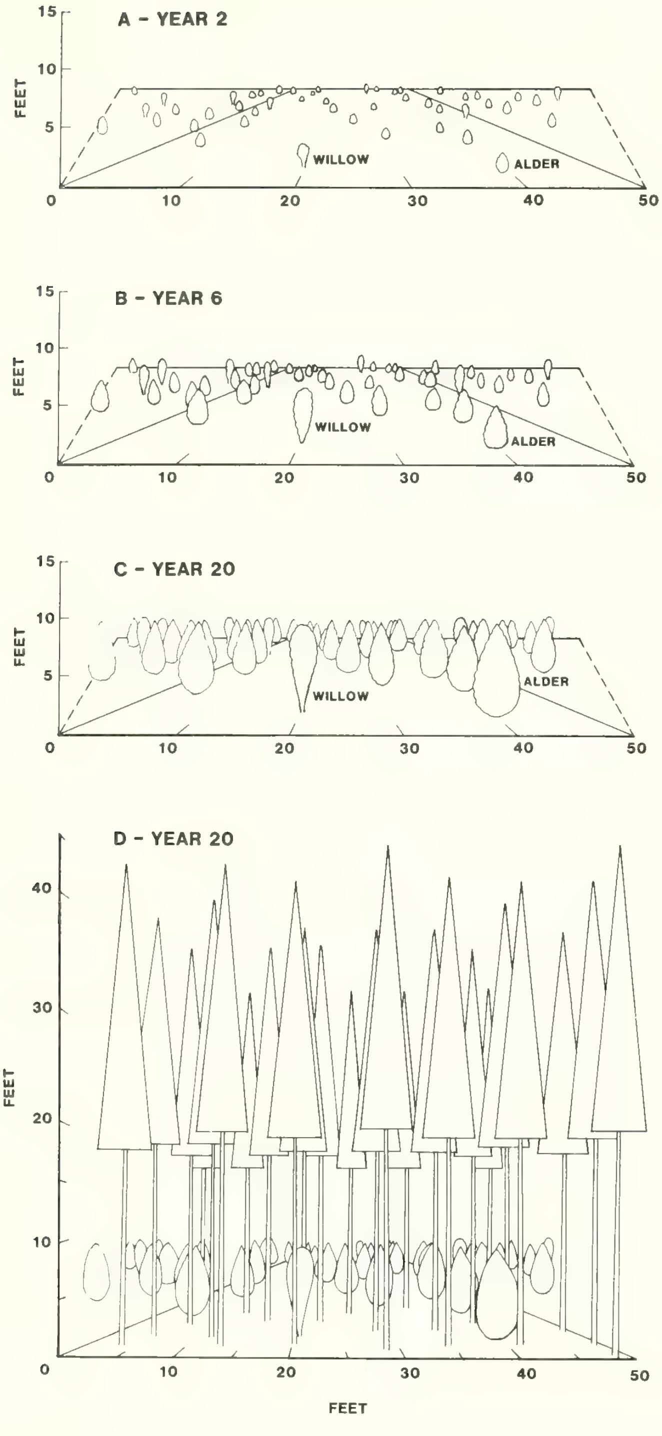

Figure 10--Heights and density of Scouler willow and Sitka alder as they are expected to appear following removal of 50 percent of the basal area in a thinning--year 2 (A), year 6 (B), and year 20 (C). Year 20, as it would appear with leave trees, is shown in D.

By year 20 (figure 10C) maximum shrub height is about 10 feet. As the tree crowns continue to develop, Sitka alder and Scouler willow will decline and eventually die. Death of shrubs would occur sooner in the untreated stands. Because mineral soil was not exposed during the treatment, seedlings of Scouler willow or Sitka alder will not become established. Figure 10D shows how the community might be expected to look at year 20 with the residual lodgepole trees included.

Biomass with this overstory canopy is calculated using equation 11. The ground layer vegetation in this scenario will respond somewhat to the opening, with maximum productivity of 400 to 500 pounds per acre (fig. 7) at 5 to 10 years after treatment. When the canopy closes, productivity will decline to pretreatment levels of around 200 pounds per acre.

Clearcut With Severe Mechanical Scarification--This example is representative of treatment with a bulldozer where mineral soil is disturbed to a depth of 2 inches or more on 100 percent of the area. Although this seems extreme, I have seen such examples. Matching this treatment with the species attributes in table 1, I would expect the root crown shrubs (Scouler willow and Sitka alder) to be uprooted and thus largely lost from the site. Because dwarf huckleberry and shinyleaf spirea are rhizomatous species, they would survive even though some rhizomes would be killed. Of the forbs and grasses in table 7, twinflower and sidebells pyrola would be lost and the other species would survive, but the amounts would be reduced.

Because so much mineral soil is exposed, more than adequate stocking of lodgepole pine would occur. The likelihood of Scouler willow seedlings and other invaders becoming established is good. If I assume 100 percent mineral soil exposure and good conditions for Scouler willow seedling establishment, then 159 potential spots would have Scouler willow seedlings. In contrast to the other two treatments, we would have no tall shrubs surviving the severe scarification. The community structure would be much different at years 2 and 5 from that shown in figures 9 and 10. By year 20 the seedlings would have grown to a height of 13 feet. The appearance of the stand would be somewhat similar to figure 9C, except no Sitka alder would be present.

Biomass at 20 years may not exceed the level present before treatment. In some cases (depending on seed sources), colonizers such as pinegrass and fireweed may make a significant impact. Shrubs and herbaceous vegetation would not be competing with the tree regeneration, but the stocking may be great enough that thinning would be required. It may be that the lack of understory vegetation would not meet other resource needs. Also, the high level of mineral soil exposure may result in unacceptable site conditions.

Any number of other treatment possibilities could be examined using this procedure. With an adequate display of community structure (such as in figs. 9 and 10), the consequences of alternatives could be at least initially judged to determine how well they fit management objectives.

IMPLICATIONS

Looking at the understory vegetation and its development relative to treatment and pretreatment conditions reveals a number of implications for the lodgepole pine stands in Montana. It is apparent from Lyon and Stickney (1976) and Stickney (1986a, 1986b) that the original pretreatment species composition is very important. Only for a few species, such as Scouler willow and fireweed, can a species not present at the beginning make much of an impact on the plant community after treatment.

The plant survival strategies and treatment combinations discussed here, and shown by examples, are quite important in determining what species, and what amounts, will be present following treatment. It is obvious from the examples that some species can be lost, or at least reduced in abundance, while other species may be increased or added as a result of specific treatments. Whether these changes are desirable or not depends on the management objectives and expectations for the posttreatment stand.

From a wildlife manager's point of view, cover and forage changes resulting from harvesting are important. Hiding cover is maximized at heights from 1.0 to 1.5 m (3.5 to 5.0 feet) (Lyon and Jensen 1980). Based on the height growth curves derived here (fig. 4), resprouts of western serviceberry, Rocky Mountain maple, Scouler willow, and Sitka alder will all provide hiding cover by year 4 in clearcuts. Scouler willow and Sitka alder are capable of providing hiding cover in the first year. Where an overstory canopy exists and resprouts are shaded, it may take from 4 to 10 years to get hiding cover. In the absence of resprouts, seedlings of Scouler willow and Sitka alder can take from 8 to 14 years to provide hiding cover.

Potential forage production for wildlife or domestic livestock can often increase dramatically following a clearcutting (fig. 6) and is also closely tied to the amount of overstory canopy (fig. 7).

The amount of hiding cover and the rate at which it develops are quite different for the three scenarios presented. In the clearcut and burn scenario the shrubs are tall enough to provide some hiding cover by year 2; by year 6 they have filled out enough to provide considerable hiding cover (fig. 9B). By year 20 the fully developed 420 Scouler willow and Sitka alder per acre (includes resprouts and seedlings) provide 100 percent hiding cover (fig. 9C). In the thinning scenario, minimal hiding cover is produced by year 6; by year 20 the 106 Scouler willow and Sitka alder per acre (resprouts) provide much less hiding cover than the clearcut scenario (fig. 10). In the third scenario, clearcut with severe mechanical scarification, all the original plants are killed so the only cover provided by shrubs is from Scouler willow seedlings. The 159 Scouler willow seedlings per acre will not be tall enough by year 6 to provide hiding cover, but by year 20 they will provide about 90 percent. Seedlings of lodgepole may provide considerable additional hiding cover in both clearcutting examples.

I have not explored the interaction of shrub development with lodgepole regeneration here, but this competition is important. In situations where the density of shrubs is considerable, possibly the first example, they may reduce lodgepole regeneration. Depending on silvicultural objectives and expected stocking, this may be good or bad. Application of these principles through a prediction methodology should help in manipulating pretreatment vegetation to fit management objectives, whether they emphasize wildlife, visual, site protection, silvicultural, or some combination of resource concerns.

If it is important to maintain some of these tall shrubs in the community, or increase them, this procedure and some of my observations are important. Given the fact that in recent history fire suppression has increased the interval between fires in lodgepole stands, they have avoided significant disturbances longer. Because these stands are becoming more closed, intolerant and semitolerant species such as Scouler willow, Sitka alder, and western serviceberry are dying out. For example, on the control plot of the example site, a number of Scouler willow root crowns are dead. If, as suspected, these plants originated from several fire cycles, continued losses may be hard to replace. They are unlikely to be replaced following one disturbance or treatment unless they are physically planted on the site.

CONCLUSIONS

1. Vegetation response to stand treatment alternatives can be assessed effectively by considering species attributes and growth rates in concert with expected levels of disturbance.

2. This prediction procedure is useful for situations where long-term data on treatment responses are not available.

3. Changes in vegetation structure used to describe developing plant communities can be valuable for assessing the consequences for wildlife, timber production, visual concerns, and grazing potential.

4. The equations presented describe height growth development of Scouler willow, Sitka alder, Rocky Mountain maple, and western serviceberry resprouts quite well. They can be used to make reasonable predictions of resprout height growth for these shrubs.

5. The sigmoid-shaped function presented describes height growth development of Scouler willow and Sitka alder seedlings quite well. It can be used to make reasonable predictions of seedling height growth for these shrubs.

6. Observations indicate that many plants of the tall shrub species are likely to be lost from old, small-stem lodgepole pine stands.

7. When tall shrubs are lost from these lodgepole pine stands, they may not be readily replaced by seed with future treatments. It may take more than one disturbance cycle to replace lost numbers.

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APPENDIX A

SCIENTIFIC NAMES OF PLANTS IN TEXT AND TABLES

Common name[1]	Scientific name
Tall Shrubs	
Black elderberry	*Sambucus racemosa*
Rocky Mountain maple	*Acer glabrum*
Rusty menziesia	*Menziesia ferruginea*
Scouler willow	*Salix scouleriana*
Sitka alder	*Alnus sinuata*
Western serviceberry	*Amelanchier alnifolia*
Low Shrubs and Herbs	
Baldhip rose	*Rosa gymnocarpa*
Beargrass	*Xerophyllum tenax*
Broadleaf arnica	*Arnica latifolia*
Common juniper	*Juniperus communis*
Dwarf huckleberry	*Vaccinium caespitosum*
Elk sedge	*Carex geyeri*
Fireweed	*Epilobium angustifolium*
Glacier-lily	*Erythronium grandiflorum*
Globe huckleberry	*Vaccinium globulare*
Kinnikinnik	*Arctostaphylos uva-ursi*
Pinegrass	*Calamagrostis rubescens*
Prickly rose	*Rosa acicularis*
Rattlesnake-plantain	*Goodyera oblongifolia*
Russet buffaloberry	*Shepherdia canadensis*
Shiny-leaf spirea	*Spiraea betulifolia*
Showy aster	*Aster conspicuus*
Sidebells pyrola	*Pyrola secunda*
Snowberry	*Symphoricarpos albus*
Strawberry	*Fragaria virginiana*
Twinflower	*Linnaea borealis*
Utah honeysuckle	*Lonicera utahensis*
Wheeler bluegrass	*Poa nervosa*
Whortleberry	*Vaccinium scoparium*

[1]Names are from Hitchcock and Cronquist (1973).

RESIDUES, BENEFICIAL MICROBES, DISEASES, AND SOIL MANAGEMENT IN COOL, EAST SLOPE, ROCKY MOUNTAIN LODGEPOLE PINE ECOSYSTEMS

A. E. Harvey, M. F. Jurgensen, and M. J. Larsen

ABSTRACT: Manipulation of forest residues has the potential to cause substantial changes in forest floor depth and composition. Such changes alter microbial communities and the accumulation, availability, or loss of soil nutrients. Forest floor changes can also alter risk factors for certain diseases and activities of ectomycorrhizal and nitrogen-fixing microbes. Alterations of soil composition or structure are likely to have both long- and short-term impacts. Natural regulation of forest floor thickness, composition, and associated processes, primarily through wildfire, generally causes extreme fluctuations in microbial activities, nutrient storage, and nutrient release. The latter is usually poorly coordinated with forest stand needs. Silvicultural systems, stand prescriptions, and regeneration methods should be directed to improve long-term nutrient storage, and to coordinate nutrient release with stand needs. Harvesting should incorporate disease sanitation, where appropriate, and limit residual stand damage.

INTRODUCTION

Development of a knowledge base for dealing with the cold, infertile ecosystems typical of the Rocky Mountain crest, particularly eastern slopes, has generally lagged behind that for warm, more productive systems. However, sufficient information is available for preliminary interpretations of advantages and disadvantages of dealing with soils and microbes in east-side Rocky Mountain sites likely to be forested with dense stands of lodgepole pine (*Pinus contorta* var. *latifolia* Engelm.). Before discussing soil-soil microbe interactions and growth of this tree species, it is desirable to examine specialized adaptations of the genus *Pinus*, and to a lesser extent other conifers, that enable productive growth in low- fertility ecosystems. It is also helpful to review some of the more influential environmental characteristics of the Rocky Mountains.

Members of the genus *Pinus*, particularly lodgepole pine and closely related species, are well adapted for, and highly successful in, low-productivity, infertile ecosystems (Miller and others 1979). Three particularly important characteristics of conifers in general, and pines in particular, make them well suited to infertile, moisture-limited environments: (1) pines are strongly mycorrhizal, a characteristic that enables them to acquire moisture, nitrogen (N), and phosphorus when quantities are too low to be available to many other plants (Harley 1969); (2) in the absence of intense competition (Worrall and others 1985), pines normally have a relatively high root/shoot ratio throughout their lives, thus maximizing soil exploration and mycorrhization to enhance nutrient and moisture acquisition (Chapin 1980; Miller and others 1979); (3) pines are adept at storing nutrients within tissues, then remobilizing and transporting them to growing tissues in times of general shortage or during temporary interruptions of supply (Chapin 1980). These properties enable pines to tolerate, even thrive, in low fertility, periodically disturbed ecosystems with limited moisture typical of east-slope Rocky Mountain sites. Periodic stress caused by wide climatic fluctuations, both long- and short-term, is also typical of these environments, as are periodic insect and disease problems (Fellin 1980; Saestedt and Crossley 1984).

Lodgepole pine is frequently found on impoverished soils such as cold-wet or cold-dry, young soils (Cochran 1985). Soils on the east slopes of the Rockies are skeletal (young) soils, low in organic matter and nutrients (particularly nitrogen and phosphorus), and are moisture limited. Various soils of low water permeability and high density are also common (Cochran 1985).

Considerable genetic variation exists within the population of lodgepole pine occupying east-slope Rocky Mountain ecosystems. Differentiation within this widespread population occurs across relatively minor environmental gradients, particularly for cold hardiness, periodicity of shoot elongation, and disease resistance (Hoff 1985; Rehfeldt 1985). There is a strong elevational factor in this

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A. E. Harvey is Supervisory Plant Pathologist, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Moscow, ID 83843; M. F. Jurgensen is Professor of Forest Soils, Department of Forestry, Michigan Technological University, Houghton, MI 49931; M. J. Larsen is Principal Mycologist, Center for Forest Mycology Research, Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, Madison, WI 53705.

variation (Rehfeldt 1985). Thus, in a highly diverse climatic, physiographic, and geological environment, tree adaptation to local conditions is important for good performance and for moderating pest-related problems.

Lodgepole pine is usually considered a fire-maintained seral species, although its characteristics vary considerably. It is an aggressive species, highly suited to pioneering environments. Cone serotiny provides an excellent means of storing and protecting genetic materials in a fire-dominated ecosystem. However, periodic stand replacement by fires is common, serotiny is variable, and fuel accumulations are sometimes high (Lotan and others 1985). Therefore, genetic materials are likely often at risk. At least local, and perhaps extensive, maladaptation of lodgepole populations in some environments is probably common though perhaps of short duration.

For example, as described by Romme and Knight (1981), midslope fires are more common than low- or high-elevation fires. If a hot, seed-destroying, midslope fire occurs, reforestation is likely to result from high- or low-elevation seed not well adapted to the midslope site. Thus, fire history may control local adaptation and even localized maladaptation may lead to poor performance and pest damage.

East-slope Rocky Mountain lodgepole pine represents a genetically fine-tuned, aggressive species operating on slim resources in a disturbance-prone, harsh, highly variable environment where constant physiological and genetic adjustments are required. In short, it is a highly dynamic system where trees are likely to be responsive to plant-microbe interactions, either positively or negatively. In discussing these interactions, we will emphasize microbial processes involved in the nitrogen economy of the soil (primarily fixation and mineralization, see table 1), uptake of nutrients (especially nitrogen) by pine root systems through the formation and activity of ectomycorrhizal fungi, and activities of specific pathogens (primarily endemic root rots) as exemplified by species of Armillaria. Other pathogens in lodgepole pine ecosystems, some more important than root rots, have been discussed elsewhere (Krebill 1975; van der Kamp and Hawksworth 1985).

NITROGEN DYNAMICS AND SOIL ORGANIC MATTER

Most site N reserves are incorporated into the molecular structure of soil organic matter (OM). The remainder is incorporated into living or dead plant bodies. Aspects of how N is brought into and moves within soil, root, and aboveground components of an ecosystem are useful in determining how best to deal with a nutrient usually limiting to tree growth. Table 1 defines terminology required to examine N dynamics.

Active N conversion processes are common to all ecosystems, but rates, quantities, and distributions are variable. Management options can be limited by any of these three factors. East-slope lodgepole ecosystems are most likely to be constrained by low amounts of total N accumulation (either from fixation or

Table 1--Definition of terms used to describe aspects of the nitrogen economy of forest soils

Term	Definition
Fixation[1]	Conversion of atmospheric N to soil N.
Nonsymbiotic	By organisms (bacteria and algae) living free in soil and other environments.
Symbiotic	By organisms (bacteria) within root nodules of living plants.
Available N	That portion of soil N in a form usable by plants.
Immobilized N	That portion of soil N tied up in organic compounds of living or dead organisms and not available for uptake by vegetation.
Mineralization[1]	Process of converting immobilized N to available N through microbial decay (bacteria and fungi).
Ammonia	NH_3, a preferred form of available N for lodgepole pine.
Nitrate	NO_3, a form of available N subject to leaching loss.
Nitrification	Process of converting NH_4 to NO_3 by nitrifying organisms (bacteria).
Total N[1]	Total amounts of organic and inorganic N, all forms (N storage).

[1]Potentially most limiting to N economy of lodgepole ecosystem.

atmospheric pollution) and slow rates of conversion (mineralization) into a form suitable for uptake by pine roots (Yavitt 1984; Yavitt and Fahey 1986). Both are temperature and moisture limited--major considerations on Rocky Mountain sites.

Table 2 shows the distribution of total nitrogen in two contrasting lodgepole stands in Wyoming; one is a typical small-stem, doghair stand, the other an open-grown stand. These data show that soil OM, including decayed woody debris, stores well over half the total N on these sites. Most of the rest is contained in small branches, twigs, foliage, or fine roots. Stem components have relatively small amounts of N, although the doghair stand has more N in bolewood than the open-grown stand (Yavitt 1984). Thus, harvesting or site preparation methods that destroy, displace, or remove nonbolewood components are likely to impose significant losses on N reserves.

Minor losses of nitrogen are probably not a great problem on many sites with good sources of N input, either biological (fixation) or via air pollutants. However, most east-side lodgepole pine sites have neither. Table 3 provides some estimates of major inputs and losses of N to an east-side forest soil, again based on a study in a Wyoming lodgepole stand. These data emphasize that rates of external input are low and that most of the N available for tree growth comes from internal cycling processes (Yavitt 1984). Any substantial losses of N reserves will be replaced slowly and are likely to cause productivity loss (Flinn and others 1980; Weber and others 1984). Because most of the site N reserves are contained in soil OM layers, depth variations from site to site or OM losses are likely to be reflected in growth rates of the trees (Graham and others in press; Weber and others 1984).

Examining an annual root zone N budget is instructive for analyzing N transfers within an ecosystem. Table 4 shows that most of the N in the root zone is contained in soil organic materials or in tree roots, and that movement of nitrogen among soil components and plant

Table 2--Total nitrogen distribution in contrasting 80- to 100-year-old *Pinus contorta* ecosystems of Wyoming, calculated from Yavitt (1984)

	Doghair stand		Open stand	
	- - - - Percent - - - -			
Trees				
Foliage	[1]10		[1]7	
Branch and twig	[1]6		[1]7	
Bole	[1]8		[1]6	
Root crown	1		1	
Lateral roots	5		1	
Fine roots	11		7	
Total	41		29	
Debris				
O_1 horizon	[1]17		[1]14	
O_2 horizon	[1]37		[1]40	
Total	54		54	
Dead fall	5		0	
Dead wood	0		[1,2]17	
Total	5	[3]83	17	[3]91
Total for all soil OM to 100-cm depth	570g/m^2		650 g/m^2	
Ecosystem total	618g/m^2		735 g/m^2	

[1]Sources of N highly vulnerable to burning or mechanized removal.
[2]Where a previous old-growth stand was terminated by wildfire and substantial volumes of bole wood remained, N storage in the decayed wood component can exceed that stored in the other debris components by two to three times (Fahey 1983).
[3]Total percentage of N that is vulnerable to burning or mechanized removal.

Table 3--Some major soil nitrogen gains and losses from a typical, 80-year-old Wyoming lodgepole pine stand, calculated from Yavitt (1984)

Source	Percentage annual N budget
Gains	
Rain	5
Snow	2
Throughfall	8
Nonsymbiotic fixation	<1
Symbiotic fixation	3
Litter fall	17
Mineralization release from soil OM	25
Losses	
Immobilization in soil OM	14
Vegetation uptake	25
Leached to or below subsoil	<1

uptake are slow (Yavitt 1984). In particular, mineralization activities are extremely slow. Although this is a potential advantage from the standpoint of nitrate loss below the root zone (Vitousek and others 1982), it also shows that the temperature and moisture limitations of these soils inhibit the decay process and make it difficult to get N released from soil OM. Not only is it difficult to get N on these sites, it is also a problem to get the N released in a form suitable for uptake and use by the trees (Fahey 1983; Yavitt and Fahey 1986; Yavitt 1984).

Although the process of nonsymbiotic nitrogen fixation contributes little to N input in an 80-year-old Wyoming lodgepole pine stand (Yavitt 1984; table 3), this process is active in western Montana forest ecosystems (Jurgensen and others 1979; Larsen and others 1980). Also, at least under relatively warm, moist, midsummer conditions, nonsymbiotic N-fixation rates at a high-altitude, western Wyoming site can be substantial (Jurgensen and others 1982). Rates of fixation and daily accumulation can be at least as high as those in western Montana (table 5). However, warm, moist conditions are infrequent in east-side forests, so annual accumulations from this source are likely small.

Because N-fixing organisms can be effective in east-side lodgepole pine soils under appropriate conditions, management actions that increase soil moisture or temperature should enhance nonsymbiotic nitrogen fixation (and mineralization). Because decayed and decaying wood can be particularly active sites of nonsymbiotic N fixation (Larsen and others 1980), modest quantities of postharvest woody residues left on site should further enhance nitrogen input, as would encouraging symbiotic N-fixers as components of the understory vegetation (Jurgensen and others 1979, 1982; Yavitt 1984).

Rates of wood decay reported for Montana and Wyoming sites (Fahey 1983; Harvey and others 1981) indicate that substantial decay should occur within 60 to 100 years and that decayed wood in contact with the soil can become an important site for nitrogen storage (table 6) Large-diameter residues, if in contact with the soil, may decay faster than small ones that rapidly dry out because of the limited summer moisture on many east-side sites. This has been reported for a variety of forest ecosystems in Washington (Erickson and others 1985). Leaving large-diameter residues is also a consideration for encouraging ectomycorrhizal activities in Northern Rocky Mountain forest soils (Harvey and others 1978, 1979, 1986).

DISTRIBUTION AND ACTIVITY OF MYCORRHIZAE

Mycorrhizal infection of root systems is considered an important adaptation of pines for normally infertile ecosystems (Harley 1969;

Table 4--Annual soil root zone nitrogen budget, in percentage of total for 1 year, from typical 80-year-old Wyoming lodgepole pine stand, calculated from Yavitt (1984)

Root zone N		N conversions		Vegetation use of N	
Roots	42				
Soil organic matter (to 100-cm depth)	40	Mineralized	5	Vegetation uptake	5
Soil solution	3	Immobilized	4		
To and below subsoil	1				
Totals	86		9		5

Table 5-- Comparative nonsymbiotic nitrogen fixation rates and amounts (among soil components) between a moderate, 250-year-old, west-slope subalpine fir stand in Montana and a cool, 160-year-old, east-slope lodgepole pine stand in Wyoming (midsummer measurements) after Jurgensen and others (1982)

Soil component	Rate/day (gN[$X10^{-9}$]g^{-1})		Amount/day (gN/ha)	
	Montana	Wyoming	Montana	Wyoming
Humus	0.3	2.1	<0.1	0.1
Decayed wood	28.1	35.9	1.2	.2
Mineral transition layer[1] (0 to 5 cm mineral)	2.1	2.7	2.9	3.8
Mineral (5 to 30 cm mineral)	[2]0.7	.8	5.1	2.3

[1]Mineral transition layer described as first 5 cm of mineral soil; mineral includes the rest of the mineral soil in core sample to a 30-cm maximum depth.
[2]Based on an assumed one-third of mineral transition layer rate.

Miller and others 1979). Formation and activity of mycorrhizal root systems on lodgepole pine seems particularly important for pioneering environments with young trees (Grossnickle and Reid 1982). Lodgepole appears typical of all Pinus spp. in that it is responsive to the presence and activity of mycorrhizal fungi (Grossnickle and Reid 1982) and in some instances it may be particularly responsive to selected species of mycorrhizal fungi (Molina and Trappe 1982).

Old decayed logs deposited on or incorporated in forest soils are an important organic constituent of east-side soils. Up to 15 percent by volume of western Montana forest soils (top 30 cm) can be made up of decayed wood (Harvey and others 1976). High concentrations of ectomycorrhizal activities in soil wood have been reported during dry seasons (Harvey and others 1978) and on dry sites (Harvey and others 1979). Thus, deposits of decayed wood derived from large residues in forest soils should enhance productivity of the site for lodgepole pine in moisture-limited areas. We currently recommend that 10 to 15 tons of 6-inch+ residues/acre (2.4 to 3.6 tons of 15 cm+ residues/ha) be left on the site after harvesting (Harvey and others 1986a,b in press).

Table 7 compares the distribution of ectomycorrhizal activities between a western Montana (west side of Continental Divide) and north western Wyoming (east side) site. These data show organic soil layers are extremely limited on the east-side site when compared to the west-side site and that, despite this limitation, ectomycorrhizal activities are also concentrated in the sparse organic layers of east-slope soils.

Because organic layers constitute a shallow horizon on the soil surface, usually less than 1.7 inches (4 cm) in Northern Rocky Mountain forests, feeder root activities are usually a surface phenomenon (Harvey and others 1986). The concentration and turnover of conifer fine roots near the soil surface, particularly in organic horizons rich in nutrients (Coutts and Philipson 1977), make significant contributions to soil OM (Vogt and others 1983). Their shallow nature also makes feeder roots subject to potential disruption by management activities that disturb the soil surface (Harvey and others 1986; Perry and others 1982). Therefore, conservation of soil OM, including old, decayed residues and stumps, appears desirable in most lodgepole pine forests. However, where such materials might serve as a potential disease inoculum source, different rules must be applied.

DISTRIBUTION, ACTIVITY, AND DAMAGE POTENTIAL OF SELECTED PATHOGENS

Although it is our intent to emphasize aspects of root disease pathology in this report because of the relationship with residue and OM management, we will also review some other aspects of pathology potentially important to east-side lodgepole pine management. This review will be brief because lodgepole pine disease relationships have been discussed in recent literature (Krebill 1975; van der Kamp and Hawksworth 1985).

The five major disease classes and their relative importance to the lodgepole pine resource are: (1) dwarf mistletoe, (2) native rusts (primarily stem rusts), (3) root and stem decays, (4) stem cankers, and (5) foliar diseases (table 8). Dwarf mistletoe is a widespread, highly destructive disease. Perhaps as many as 50 percent of the lodgepole pine stands on east-slope sites are infested (van der Kamp and Hawksworth 1985). Fortunately, management methods to reduce damage from this disease are available, although applying them is often difficult.

Table 6--Decay and nitrogen content in dead lodgepole pine bole wood and residue suspended above and lying on soil in Wyoming, after Fahey (1983)

Residue description	Weight loss	Age	Specific gravity	N. content	N gain
	Percent	Yr	(g/cm^3)	Percent	
Standing dead	20	110	--	--	--
Suspended deadfall	10	80	0.41	0.065	0
Deadfall on ground (cylindrical)	60	[1]55	0.34	0.085	[2]31
Deadfall on ground (compressed)	--	--	0.24	0.20	208

[1]Assumes falldown occurred at 15 years.
[2]Increase over suspended stage.

Table 7--Comparative distribution of ectomycorrhizal activity (among soil components) between a moderate 250-year-old, west-slope stand in Montana and a cool 160-year-old, east-slope stand in Wyoming. The latter supports primarily lodgepole pine; both are classified within the subalpine fir habitat series

Soil component	Soil component volumes		Number of active short roots	
	Montana[1]	Wyoming[2]	Montana[1]	Wyoming[2]
	Percent			
Litter	2^{a}_{x}[3]	2^{a}_{x}	0^{a}_{-}[4]	6^{a}_{x}
Humus	13^{a}_{y}	3^{a}_{x}	74^{b}_{x}	37^{a}_{y}
Decayed wood	14^{a}_{y}	1^{a}_{y}	19^{a}_{yz}	28^{a}_{y}
Mineral transition layer[5] (0 to 5 cm mineral)	16^{a}_{y}	16^{a}_{x}	6^{a}_{y}	28^{a}_{y}
Mineral (5 to 30 cm mineral)	55^{a}_{z}	78^{a}_{z}	1^{a}_{z}	1^{a}_{x}
All organics combined	29^{a}_{x}	6^{b}_{x}	93^{-}_{x}	71^{-}_{x}
All minerals combined	71^{a}_{y}	94^{b}_{y}	7^{-}_{x}	29^{-}_{x}

[1]Montana data derived from Harvey and others (1978).
[2]Wyoming data derived from Jurgensen and others (1982); data from both States at estimated site maximum (late spring), see Harvey and others (1978).
[3]Differing letters indicate significant differences between sites (a,b) or within site (x, y, z), based on two-sided t-test.
[4]Indicates comparison not possible or available.
[5]Mineral transition layer described as first 5 cm of mineral soil; mineral includes the rest of the mineral soil in core sample to a 30-cm maximum depth.

Table 8--Fungus-caused diseases, by class, listed in approximate descending order of risk to lodgepole pine, after Ives (1983), Krebill (1975), and van der Kamp and Hawksworth (1985)(taxonomic designations as currently accepted)

a. Stem rusts
- Endocronartium harknessii (J.P. Moore) Y. Hirats
- Cronartium coleosporioides Arth.
- C. commandrae Peck
- C. comptoniae Arth.

b. Root decays
- Armillarea mellea (Vahl:Fr.) Quel.
- Inonotus circinatus (Fr.) S.C.Teng (=Polyporous tomentosus var. circinatus)
- Phaeolus schweinitzii (Fr.) Pat. (=Polyporous schweinitzii)
- Inonotus tomentosus (Fr.) S.C.Teng (=Polyporous tomentosus)
- Phellinus weiri (Murr.) Gilberts.(=Poria weirii)
- Verticicladiella wageneri Kendr. (=Ceratocystis wageneri)
- Heterobasidion annosum (Fr.) Bref. (=Fomes annosus)
- Mixtures and others

c. Stem decays
- Phellinus pini (Bros.:Fr.) A. Ames(=?Phellinus vorax)
- Peniophora pseudo-pini Weres. et Gibson
- Coniophora puteana (Schum.:Fr.) Karst.
- Stereum sanguinolentum (Alb. et Schwein.:Fr.)Fr.
- Inonotus tomentosus (Fr.) S.C. Teng
- Dichomitus squalens (Karst.) Reid (=Polyporus anceps)
- Mixtures and others

d. Stem cankers
- Atropellis piniphilla (Weir) Lohman et Cas
- A. pinicola Zeller et Good.
- Dasyscyphus sp. Gray
- Tympanis sp. Tode
- Diplodia sp. Fr.
- Valsa sp. Fr.
- Others

e. Foliar diseases
- Lophodermella concolor (Dear.) Darker
- L. montivaga Petrak
- Elytroderma deformans (Weir) Darker
- Lophodermium pinastri(Schred.ex.Hook.)Chev
- Scirrhia pini Funk et Parker (=Dothiostroma Pini)
- Coleosporium asterum (Diet.) Syd.
- Others

f. Stains
- Amylostereum sp. (Boid.) (=Stercum)
- Ceratocystis sp. Ell. et Halst(=Ophiostoma
- Europhium sp. A. K. Parker
- Leptographium sp. Lagerb. et Melin
- Verticicladiella sp. S. Hughes
- Others

Native rusts (Cronartium spp.) are also widespread and capable of inflicting heavy damage (Krebill 1975). However, geographic, site, and habitat type factors limit the distribution of several important native rusts (Beard and others 1983; Geils and Jacobi 1984). Also, in cases where an alternate host is required, there is the additional requirement for conditions suitable to support the alternate host in proximity to susceptible forest stands (Krebill 1975). Thus, distribution of many rust diseases tends to be highly discontinuous. Those that do not require the alternate host, for example gall rust, tend to be more widespread. In general, thinning, spacing, and pruning are effective controls, except where damage (and risk) is high. Under such conditions, stocking levels should be high enough to offset mortality. Genetic resistance to native rusts has been noted (Hoff 1985) and will eventually play a significant role as an aid in controlling these diseases in high-damage, high-risk circumstances.

Potentially, the most damaging root rot pathogen is likely to be Armillaria (James and others 1984; Krebill 1975; Morrison 1981; van der Kamp and Hawksworth 1985). However, recent work at the Intermountain Research Station indicates that Armillaria distribution and damage is strongly constrained by habitat type (climate) throughout most of the Inland Northwest, including many habitats likely to support east-side lodgepole pine stands (McDonald 1985, personal communication). Table 9 shows the distribution of this important pathogen, and damage patterns, on a number of east-slope sites. These data, though limited, indicate high potential for damage due to Armillaria activity only in relatively productive habitat types for the area (ABLA/CLUN, ABLA/MEFE, ABLA/VAGL, PSME/PHMA, PSME/VAGL). A substantial portion of east-slope habitat types may be beyond the environmental latitude of this organism and are, therefore, not likely at risk.

Table 9--Status of Armillaria on 0.04-ha plots (all conifer species)[1] located in subalpine fir and Douglas-fir habitat series in the Northern Rocky Mountains listed in approximate order of decreasing risk to disease damage, after McDonald and others [in press]

Habitat type	Climatic characterization	Number of plots	Percentage with Armillaria	Percentage with pathogenic Armillaria
Abies lasiocarpa series[2]				
ABLA/CLUN	Cool/moderate	5	80	100
ABLA/MEFE	Cold/moderate	6	83	60
ABLA/VAGL	Cool/dry	3	100	33
ABLA/ALSI	Cold/moderate	2	100	0
ABLA/ACGL	Cool/dry	1	100	0
ABLA/CACA	Cold/wet	1	0	--
ABLA/STAM	Cold/wet	1	0	--
ABLA/VACA	Frost pockets	2	0	--
ABLA/XETE	Cold/dry	6	0	--
ABLA/VASC	Cold/dry	8	0	--
Pseudotsuga menziesii series				
PSME/PHMA	Warm/dry	6	67	75
PSME/VAGL	Cool/dry	2	100	50
PSME/VACA	Frost pockets	1	0	--
PSME/JUCO	Hot/dry	2	0	--
PSME/CARU	Hot/dry	6	0	--

[1]Lodgepole pine can be considered moderately susceptible to damage by this important disease.

[2]Habitat series designations as reported in Pfister and others (1977).

In areas of high damage potential, residue management practices may affect this disease. Armillaria uses stumps, root systems, and perhaps logging slash as a food base from which to infect living trees. Thus, a reduction of food base materials should be of some benefit, at least to heavily impacted areas. This may also be the case in moderate-hazard habitat types with visible damage. Disturbance frequently leads to increased Armillaria damage (McDonald and others, in press; McDonald 1985 personal communication). However, lodgepole pine is only moderately susceptible to this disease, and most other root rots as well (Hobbs and Partridge 1979; James and others 1984; McDonald and others, in press). Therefore, the primary damage and benefits from management would likely be in fir and spruce components of mixed stands.

Other root rot and stem decay organisms also have discontinuous distribution patterns (Bella 1985; Vyse and Navratil 1985; Whitney and others 1983). In these cases, our knowledge of distribution patterns is fragmentary and not helpful for assessing potential risk in the absence of diagnosed damage in or near a stand to be harvested. Root rots, other than Armillaria, are not likely to be affected by residue management methods. Phellinus root rot management has been attempted in the Pacific Northwest with removal of infected stumps (Theis and Russell 1984). Results do not appear cost effective, particularly for low-productivity sites. It is, however, unlikely that Phellinus will cause significant damage to lodgepole pine east of the Continental Divide. Residue removal may reduce inoculum load (spores) for stem decay organisms likely to produce fruiting bodies on logging slash. However, only 16 fungi have been reported to decompose logging slash and cause significant losses in live, standing timber (Spaulding and Hansbrough 1944), and many of these are not common in the Rocky Mountains. In most cases, spores arriving from outside harvested stands are probably sufficient to cause infection of residual trees if historical damage in the stand has been high.

As with Armillaria, the incidence of other root and stem decays, and other diseases as well, can be increased with partial cutting (Bella 1985; Johnstone 1981). In most cases, the affected diseases are those already evident in the stand before harvest. In the case of high hazard Armillaria sites (table 9), damage might not be evident before harvest. In high-hazard habitat types, it would be prudent to treat as if postharvest damage by Armillaria is likely--favor resistant species and remove any infected slash.

There are potentially important root decay scenarios with lodgepole pine that involve interactions between the respective pathogens and insect pests or fire. In one, insects (Dendroctonus spp.) simply act as a vector (carrier) for black root stain (Verticicladiella spp.). This disease has considerable potential to damage lodgepole pine in the Interior West (Bertagnole and others 1983; Hobbs and Partridge 1979; James and others

1984). Fortunately, it does not persist in dead root systems, so it can be managed with appropriate harvesting.

In another scenario, fire damage to roots provides infection courts for root and stem decay organisms in Oregon. Infection predisposes trees to insect attack (*Dendroctonus ponderosae* Hopk.), providing dispersal trees that increase insect damage and mortality, eventually leading to return of fire (Gara and others 1985). Presumably, managing such stands (fuel) to limit fire could break this cycle and, in turn, reduce root rot, decay, and insect damage.

Lastly, a significant and consistent association between infection of the root pathogen *Armillaria* and incidence of infestation of mountain pine beetle (*Dendroctonus ponderosae* Hopk.) in lodgepole pine has also been documented in Utah. In this case it was suggested that survival of the insect during its low-population cycle may be favored by the presence of *Armillaria* root disease (Tkacz and Schmitz 1986). An association with fire-damaged roots as a predisposing factor, as noted by Gara and others (1985) was not observed. However, damage by dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.) and comandra rust (*Cronartium comandrae* Pk.) were noted as possible predisposing factors.

There are also two decay-related disease scenarios where exclusion of pathogens may become an important management consideration for east-side lodgepole pine. One pertains to annosus root rot (*Heterobasidion annosum*, see table 8). This pathogen, thus far, is relatively rare in lodgepole pine stands of the western United States and Canada. However, it causes a great deal of damage in other parts of the world. The organism native to our area may not be as pathogenic as elsewhere (van der Kamp and Hawksworth 1985). If so, excluding more pathogenic strains may be critical. If imported, more damaging strains may have potential to become established and cause extensive damage.

The second pathogen is the organism responsible for *Armillaria* root rot. *Armillaria mellea* (table 8) has been generally assumed to be the damage-inciting culprit. However, there is increasing evidence that several *Armillaria* species may be involved or that there may be variation within the species that affects the distribution and damage patterns shown in table 9 (McDonald 1985, personal communication). If this turns out to be the case, local and regional exclusion or measures specific to *Armillaria* species present may be helpful for limiting this disease in the future.

Most other common diseases of lodgepole pine (table 8) are only locally important and infrequently inflict major damage. *Atropellis* canker and several foliar pathogens can cause serious damage, but the damage is usually limited to small areas. If economical, development of resistance is a viable approach for dealing with many of these relatively m[illegible]r pathogens. In some instances, thinning [illegible] reduce infection levels (Stanek and oth[illegible] 1986; Whitney and others 1983). Table 10 summarizes disease damage potential and possible controls for east-side lodgepole pine stands. All in all, our pathological problems generally appear less limiting than insect, soil productivity, silvicultural, or economic problems. However, the presence of disease damage potential, particularly by dwarf mistletoe, root rots, or native rusts, complicates other limitations because management actions that solve one problem frequently complicate or enhance others.

THE TRADEOFF PROBLEM AND SITE-SPECIFIC MANAGEMENT

Management of east-side lodgepole pine frequently presents choices in offsetting values, particularly with respect to manipulating microbial actions. For example, residue reduction (inoculum removal) for *Armillaria* control reduces N reserves, OM, and N-fixation. Similarly, fuel management involves short-term reductions of OM. However, long-term protection against excessive losses of OM, and retaining high-N-content foliage and twigs may increase inoculum for foliar pathogens. Broadcast burns that protect N reserves may not be intense enough to control competition or provide adequate site preparation. On the other hand, too much site preparation may result in high seedling density, but reduces early root proliferation and extension.

Table 11 is provided as a reminder of some hypothesized estimates of major tradeoffs to emphasize that the manager is slave to many masters. The determination of which master is most critical to a particular site is the most difficult assessment. This becomes particularly difficult in instances where time since disturbance can completely change potential impact, for example, decay of fine fuels versus large fuels. If properly determined, conflicts can be minimized, and those that remain can be addressed with reasonable confidence in an appropriate outcome.

Table 10--Relative damage and treatments for fungus-caused diseases of lodgepole pine, after Ives (1983), Krebill (1975), van der Kamp and Hawksworth (1985), Whitney and others (1983)

Disease class	Potential control	Damage potential
Stem rusts	Selective removal Alternate host control for Cronartium sp. Resistance	Generally moderate, but locally high
Root decays	Clearcut Stump removal or treatment Broadcast burn? Species conversion or mix Avoid or treat high hazard sites Guard against import or movement of disease organisms? Use resistance if it becomes available? Do not use highly susceptible species on high hazard sites	Generally moderate, but locally high
Stem decays	Reduce residual stand damage	Generally low, but locally high
Stem canker	Stand opening Avoid or treat high hazard sites	Locally moderate
Foliar diseases	Use resistance if it becomes available?	Generally low, but locally and temporally moderate

Table 11--Some examples of hypothesized tradeoffs between beneficial (+) and detrimental (-) environmental effects of some selected stand treatment alternatives on lodgepole pine ecosystems

Treatment alternatives	Environmental effect			
	Fire hazard	Pest hazard	Symbiont[1] activity	Nutrient supply
Clearcut (conventional utilization)	+-[2]	+-	+-	++
Clearcut (intensive utilization)	+	++	-	+-
Thin (heavy)[3]	+-	+-	+-	+
Thin (light)[3]	+-	+-	0	+
Mechanical site prep.	++	+	-	--
Prescribed burn	+	+	-	+
Pile and burn	+	+	-	--
Windrow and burn	+	+	-	-
Wildfire (hot)	++	++	--	--
Planted tree regeneration	0	+	+	0
Natural tree regeneration	0	+-	+	0

[1]Includes both ectomycorrhizal and free living, N-fixing bacterial activities based primarily in soil organic layers.

[2](+-) indicates effect depends on time, local conditions, or degree of treatment; (0) indicates no effect; (++ or --) indicates effect is very strong.

[3]For example, one-third and two-thirds stand density reduction (thinning) treatments described in STEM field site descriptions (this proceedings).

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Management and Economic Consequences

Chaired by: Robert E. Benson

The principal justification for harvesting in presently submarginal stands is to facilitate management of the stand, and to manage or influence other resources and uses on the site. Objectives relating to fire (fuels) management, wildlife habitat improvement, insect control, and other such concerns are typically integrated in the harvesting or thinning treatment prescription. The use of harvesting prescriptions and activities to achieve a combination of timber and nontimber management objectives raises questions of costs incurred and benefits achieved. In order to make valid decisions among treatment alternatives, managers need to be able to evaluate tradeoffs. Discussed in this section are some of the nontimber resource management concerns associated with harvesting in small lodgepole pine, and economic evaluation of alternative stand treatments.

PREDICTED RESIDUES AND FIRE BEHAVIOR IN SMALL-STEM LODGEPOLE PINE STANDS

James K. Brown and Cameron M. Johnston

ABSTRACT: Fuel loading, fireline intensity, and expected fire size were determined after harvesting small-stem lodgepole pine stands. Curves relating predicted fireline intensity to slash fuel loading and windspeed are presented. Removing about 15 tons per acre of residues reduced fireline intensity by half, but in some situations it still was too high to allow direct suppression. Effects of cutting level, method of felling, fuel removal, lopping, and slash age on expected fire size were evaluated. Commercial thinning with directional felling reduced expected fire size to that of undisturbed forest within 5 years. Nominal lopping was ineffective in reducing expected fire size. Methods for managers to use in appraising slash fuel hazard are reviewed. Economic analysis of fuel treatment is discussed.

INTRODUCTION

Thinning forest stands creates fuels of great concern to land managers. Wildfire in slash can be difficult to control and lead to development of large fires that are expensive to suppress. However, fuel quantities and fire behavior can vary substantially depending on the number and size of trees cut and on how the slash is treated after cutting. Appraisals of fuel and fire behavior potentials and the costs and benefits of treatment can help in determining the best alternative for managing fuels created by cutting.

Techniques developed over the past 15 years for appraising fuels and fire behavior potentials make possible mathematical and objective means to evaluate slash fuel problems. The purpose of this paper is to describe fuel quantities, potential fire intensity, and expected fire size resulting from various harvesting treatments that might be used in small-stem lodgepole pine stands. Management implications of the fuel and fire behavior appraisals due to various harvesting alternatives are discussed.

Paper presented at Workshop on Management of Small-Stem Stands of Lodgepole Pine, Fairmont Hot Springs, MT, June 30-July 2, 1986.

James K. Brown is Project Leader and Cameron M. Johnston is Computer Programmer Analyst, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT.

PROCEDURES

Fuel and fire behavior were determined for small, overstocked stands of lodgepole pine predominantly 6 inches or less diameter at breast height (d.b.h.). A study of harvesting and silvicultural alternatives in small-stem lodgepole pine by the Intermountain Research Station Systems of Timber Utilization for Environmental Management (STEM) Program provided the stand conditions for predicting fuel loadings and fuel size distribution. Fire behavior predictions were based on fuel characteristics and varying fuelbed compactness levels that represent a wide range of stand treatment options. Some of these options were not a part of the STEM study. Expected fire size was determined for various combinations of fuel loading, lopping, directional felling, residue removal, and slash age.

Nineteen units in the Deerlodge, Lewis and Clark, and Gallatin National Forests were harvested by cutting approximately 33 and 66 percent of the live tree basal area. Another 14 units were designated as controls. Before cutting, stand conditions were:

	Low	High	Mean
No. trees per acre	860	9,400	5,110
Basal area (ft^2/acre)	125	260	200
Proportion of trees dead	0.12	0.41	0.26

Treatments called for felling and removing all harvest trees 3 inches and greater at the stump and for felling and slashing excess stems less than 3 inches at the stump. Whole trees were skidded by hand or cable to skid roads, then by rubber-tired skidders. Crawler or farm tractors were used to move the material to haul roads. Methods varied among the cutting units.

Fuel loadings were predicted using tree crown weight relationships (Brown 1978) contained in QDEBRIS, which is available through the Forest Service Northern Region shared computer library and managed by the Aviation and Fire Management Staff. Downed woody fuel loadings were also inventoried after the harvesting treatments using the planar intersect method (Brown 1974).

FIRELINE INTENSITY

Fireline intensity was predicted using the computer program HAZARD (Puckett and others 1979). Predicted total slash fuel loadings were entered in increments of 5 tons per acre. Average

d.b.h. of harvested trees on individual units ranged from 1.9 to 4.0 inches. Foliage and branchwood proportions vary only slightly over this d.b.h. range (Brown and others 1977); thus, an average d.b.h. distribution was used for all units to partition the total loading increments into 1-inch d.b.h. classes required to operate program HAZARD (fig. 1). Fuel moisture contents were the typical midsummer values in program HAZARD of 5, 7, and 9 percent for the 1-, 10-, and 100-hour timelag dead fuel classes.

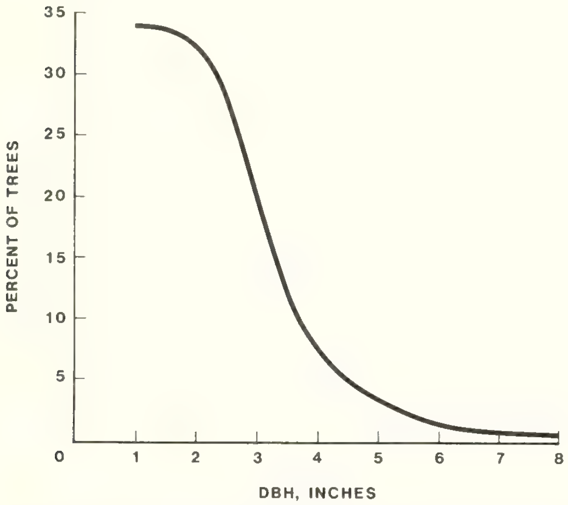

Figure 1--Average fraction of harvest trees by d.b.h. based on data from all harvested units.

Methods of felling, skidding, and lopping influence fireline intensity by altering fuel depth and, in turn, fuelbed compactness (Albini and Brown 1978). Fireline intensity was determined for two fuelbed compactness options:

1. Commercial thinning with directional felling and slashing of leave stems (fig. 2). This fuelbed represents relatively compact slash typical of ground-lead skidding. It applies to the STEM study harvested units where directionally felled stems were slashed every 6 feet or less and branches greater than 1 inch in diameter were lopped.

2. Precommercial thinning with felling in all directions (fig. 3). It was assumed that slash received nominal lopping, which leaves all branches within 2 feet of the ground and boles within 1 foot of the ground. This fuelbed has only slightly compacted slash; it is not compacted by equipment.

Fireline intensity was determined for 1-year-old and 5-year-old slash. One-year slash has all foliage attached to branches and is at maximum flammability. Five-year slash has lost most of its foliage and has settled considerably (Albini and Brown 1978). Five-year slash can be expected to remain flammable for 20 years or more.

Fireline intensity for the untreated control units was determined using the standard Intermountain

Figure 2--This commercial thinning with directional felling and slashing of leave stems in lodgepole pine left 35 tons per acre of all-sized debris. It illustrates highly compacted slash typical of the STEM study treatments.

Figure 3--This precommercial thinning in grand fir (Abies grandis) left 40 tons per acre of all-sized debris. Although the slash was unlopped, the picture illustrates loosely arranged material characteristic of uncompacted or slightly compacted slash.

Fire Sciences Laboratory (IFSL) Model 8 and 10, which correspond to National Fire-Danger Rating System (NFDRS) Fuel Models H and G, in the BEHAVE fire behavior prediction system (Andrews 1986). Model 8 represents nominal surface fuels in closed forest stands (Anderson 1982). Based on fuel inventories, it most nearly represents the untreated stands in the STEM study. Model 10 represents a heavy accumulation of surface fuels in closed forest stands that sometimes occurs in lodgepole pine.

EXPECTED FIRE SIZE

The general approach to determining expected fire size and burned area is decision analysis (Howard 1973), which incorporates probabilities to deal with uncertainties about future fire occurrence, weather, fire behavior, and fire size. We determined expected fire size in a manner similar to the activity fuel appraisal process described by Hirsch and others (1981). They studied precommercial thinning on the Hungry Horse Ranger District, Flathead National Forest. Western larch, Douglas-fir, and Engelmann spruce were thinned to 200 stems per acre in 100-acre blocks distributed throughout a 10,000-acre stand. Interviews with District fire experts established the fire size estimates. They assumed that fire in unthinned stands would be easy to suppress but that fire in slash would be of high intensity and uncontrollable until it burned the slash.

Expected fire size is a probability-weighted average of all possible fire outcomes as shown in figure 4. It indicates average fire size given that a fire occurs. Expected acres burned annually for a specified management unit can be computed by multiplying expected fire size times fire occurrence rate. We used expected fire size as a measure of fuel hazard for comparing fuel treatments.

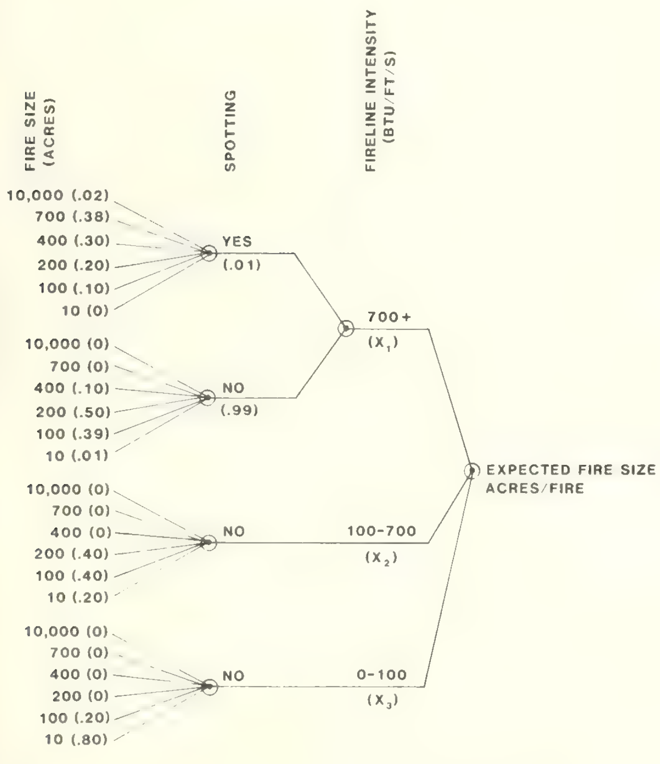

Figure 4--This decision tree summarizes events leading to expected fire size. Probabilities are in parentheses. The probability of an outcome (fire size) is the product of probabilities for all branches leading to the outcome. The expected fire size is the sum of all products of acres burned and their respective probabilities.

The decision tree in figure 4 was solved for the following stand treatment alternatives and fuel situations possible in small-stem lodgepole pine forests:

1. Unharvested stands represented by standard IFSL Fuel Model 8 (5 tons per acre of less than 3-inch diameter surface fuel) and Model 10 (10 tons per acre).
2. Precommercial thinning with random felling (felled in all directions or jack-strawed) --moderate cut (25 tons per acre).
3. Precommercial thinning with random felling--heavy cut (45 tons per acre).
4. Commercial thinning with random felling --moderate cut with trees greater than 2.5-inch d.b.h. removed (10.4 tons per acre after removal).
5. Commercial thinning with random felling --heavy cut with trees greater than 2.5-inch d.b.h. removed (18.4 tons per acre after removal).
6. Commercial thinning with directional felling--moderate cut with trees greater than 2.5-inch d.b.h. removed (10.4 tons per acre after removal).
7. Commercial thinning with directional felling--heavy cut with trees greater than 2.5-inch d.b.h. removed (18.4 tons per acre after removal).

All of the slash fuel models were evaluated by the decision tree in lopped and unlopped conditions and at 1- and 5-year ages.

The fireline intensities representing the different branches in figure 4 were based on general difficulty-of-suppression guides (Roussopoulos and Johnson 1975), explained later.

The probabilities for fireline intensity represented by X_1, X_2, and X_3 in figure 4 were determined for all fuel models and fire occurrence data from the Hebgen Lake Ranger District, Gallatin National Forest. The procedures involved:

1. Determining a cumulative probability distribution for the National Fire-Danger Rating System Burning Index for days that had fires in the lodgepole pine cover type (fig. 5). Burning Index was determined for 113 fire days from the 14-year period, 1970 to 1984.
2. Determining fuel moisture content and windspeed from weather records for days having Burning Index at the 0.05, 0.1, 0.2, 0.4, 0.6, 0.8, 0.9, 0.99 percentiles (table 1).
3. Computing fireline intensities using program HAZARD and the windspeed and fuel moisture data in table 1. Determining the cumulative frequency distribution of fireline intensity by plotting the fireline intensity values against the percentiles in table 1 (fig. 6).
4. Determining the probabilities (table 2), using figure 6, for the critical fireline intensity of 100 Btu/ft/s, which indicates the limit beyond which people are unable to work at the fire edge, and for 700 Btu/ft/s, which indicates the limit of direct attack (Roussopoulos and Johnson 1975).

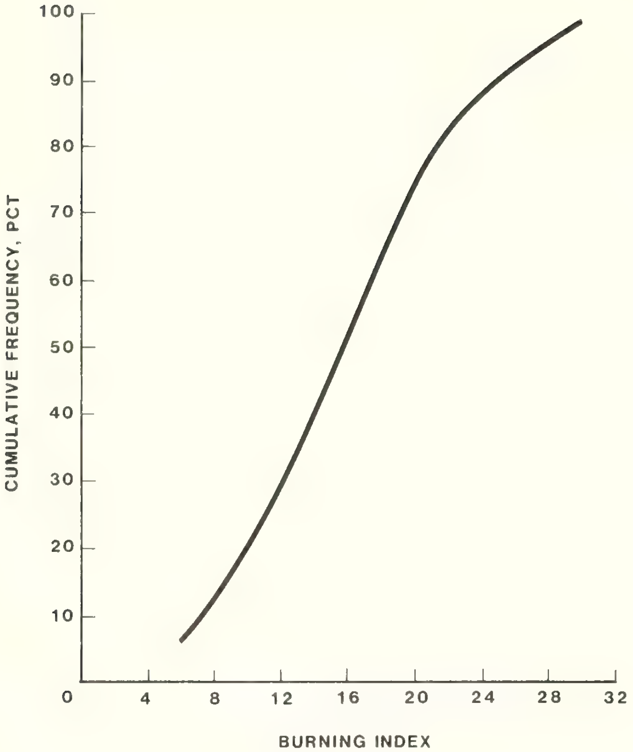

Figure 5--Cummulative frequency distribution for Burning Index on days with fires.

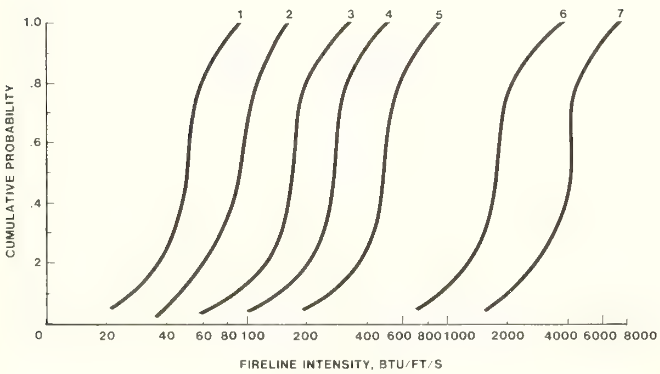

Figure 6--Cumulative frequency distribution of fireline intensity based on fire days for seven heavy cutting treatments and fuel conditions: (1) C--directional fell, lopped 5-year slash; (2) C --random fell, unlopped 5-year slash; (3) C--directional fell, lopped 1-year slash; (4) C--random fell, lopped 1-year slash; (5) C--random fell, unlopped 1-year; (6) P--random fell, lopped 1-year slash; (7) P--random fell, unlopped 1-year slash. Abbreviations are: C--commercial thinning, and P--precommercial thinning.

FUEL QUANTITIES

Harvesting created considerable amounts of fuel on most units (table 3). We predicted an average of 11 tons per acre more woody fuel for 66 percent harvesting of initial basal area than harvesting 33 percent of initial basal area. However, postharvest inventories indicated only a small difference in loadings between the 33 and 66 percent basal area levels. Apparently, more residues were removed on the heavier thinning treatments.

The difference between predicted and inventoried fuel quantities in table 3 is largely due to fuel removed and to unknown quantities of preharvest downed woody fuel. Deducting inventoried fuels from predicted residues plus preharvest fuels (average of control plots) indicates that an average of 13 tons per acre of woody fuel was removed by operators. Another 2 tons per acre of foliage, which averaged 18 percent of less than 3-inch woody residues, was probably removed. However, removal varied considerably by operator, ranging from about 7 to 20 tons per acre. Fuel depth was low, averaging 6 inches for all units. This depth and the average fuel loading (table 3), adjusted to include foliage, yielded an average fuelbed bulk density of 2.0 lb/ft^3, which is 2.5 times more compact than assumed in the precommercial thinning fuelbed option.

FIRELINE INTENSITY

Curves of fireline intensity are shown for commercial thinning slash (fuelbed option 1) at 1 year of age (fig. 7) and for precommercial thinning slash (fuelbed option 2) at 1 year of age (fig. 8) and at 5 years of age (fig. 9). These curves can be used to predict potential fireline intensities based on fuel loadings under dry summertime conditions. Fireline intensity, which is the heat produced from a unit width cross section of the propagating flame front, is probably the most useful characteristic of fire behavior for evaluating slash fuel hazard. The fireline intensity relationships in figures 7, 8, and 9 can be used to appraise the difficulty of suppression based on the following guides (after Roussopoulos and Johnson 1975):

Fireline Intensity	Flame Length	Fire Situation
(Btu/ft/s)	(Ft.)	
<5	<1	Marginal burning. Few fires exist at this level.
20 to 50	2 to 3	Easily attacked and controlled. People can work right up to the edge of the fire without protection.

Table 1--Windspeed and fuel moisture content for days having Burning Index at specified cumulative frequencies (fig. 5)

Variable	Percentile							
	0.05	0.1	0.2	0.4	0.6	0.8	0.9	0.99
Windspeed at 20 ft, mi/h	5	5	7	8	8	9	10	11
Fuel moisture, percent								
1-hour timelag	14	10	8	7	6	6	5	4
10-hour timelag	17	17	12	9	7	6	5	4
100-hour timelag	18	17	14	12	12	11	9	8
1,000-hour timelag	30	25	21	19	14	14	13	12

Table 2--Probabilities of specified fireline intensities for various fuel models and fuel conditions determined from cumulative frequency distributions of fireline intensity (fig. 6). Abbreviations are: PC--precommercial thinning, and C--commercial thinning

Fuel model	Nominal lopping	Fireline intensity (Btu/ft/s)		
		0 to 100	101 to 700	700+
One-year-old slash				
PC - random fell, moderate	no	0	0.05	0.95
PC - random fell, moderate	yes	0	.16	.84
PC - random fell, heavy	no	0	0	1.0
PC - random fell, heavy	yes	0	0	1.0
C - random fell, moderate	no	.075	.925	0
C - random fell, moderate	yes	.175	.825	0
C - random fell, heavy	no	0	.94	.06
C - random fell, heavy	yes	.05	.95	0
C - directional fell, moderate	yes[1]	.80	.20	0
C - directional fell, heavy	yes[1]	.14	.86	0
Five-year-old slash				
PC - random fell, moderate	no	.05	.95	0
PC - random fell, moderate	yes	.05	.95	0
PC - random fell, heavy	no	0	.94	.06
PC - random fell, heavy	yes	0	.94	.06
C - random fell, moderate	no	1.0	0	0
C - random fell, moderate	yes	1.0	0	0
C - random fell, heavy	no	.65	.35	0
C - random fell, heavy	yes	.65	.35	0
C - directional fell, moderate	yes[1]	1.0	0	0
C - directional fell, heavy	yes[1]	1.0	0	0
Undisturbed				
IFSL Model 8	-	1.0	0	0
IFSL Model 10	-	.175	.825	0

[1]More compact than nominal lopping because stems are slashed every 6 feet and branches 1 inch or greater in diameter are lopped.

Table 3--The mean and range of inventoried and predicted fuel quantities for control plots and plots harvested by removing 33 and 66 percent of initial basal area (Ba)

Estimate	Woody fuel size	Low	High	Mean[1] 33 percent	66 percent	All
	Inches	Tons per acre				
Inventory						
Postharvest	0 to 3	6.2	35.6	17.6	20.5	18.9
Postharvest	3+	.4	7.7	3.0	3.5	3.2
Control	0 to 3	.9	10.6	--	--	5.3
Control	3+	0	18.1	--	--	3.7
Prediction						
Residue	0 to 3	8.7	44.4	21.7	32.3	26.7
Residue	0 to 3 and foliage	11.1	55.8	26.2	39.4	32.4

[1]Number of plots were control = 14; 33 percent Ba/acre = 10; and 66 percent Ba/acre = 9.

Fireline Intensity	Flame Length	Fire Situation
100	4	This is about the limit beyond which people are unable to work at the fire edge.
500 to 700	8 to 9	Spotting begins to be a problem and the limit of direct attack is probably reached in this range of intensities.
1,000	11	Crowning can be expected to begin. Serious spotting may occur.
20,000 to 30,000	40 to 50	Major conflagration. Long-range spotting occurs. Tree blowdown may occur. Flaming zone depths of up to one-fourth mile can arise.

Fireline intensity for a fuel loading of 20 tons per acre, which was nearly the average for the 33 and 66 percent basal area removal treatments (table 3), entered the 500 to 700 Btu/ft/s hazard band at the following windspeeds (figs. 7, 8, and 9):

Fuelbed	Windspeed (Mi/h)
Commercial thinning 1-year slash	12
Precommercial thinning 1-year slash	4
Precommercial thinning 5-year slash	17

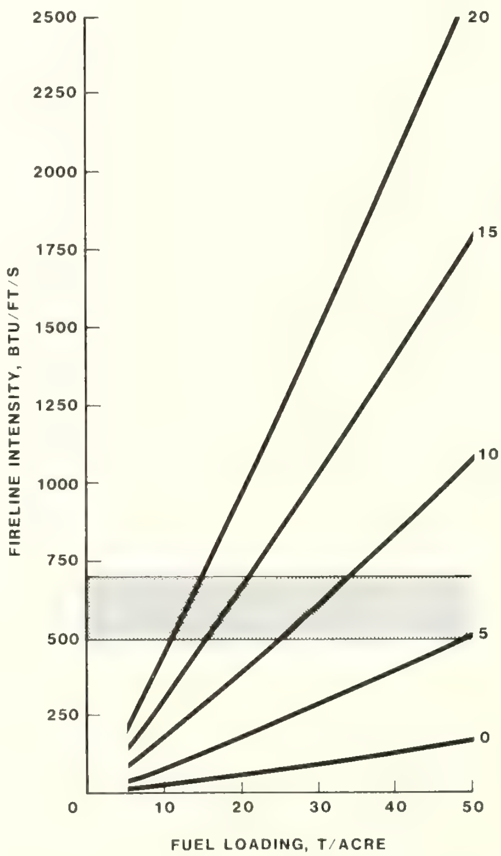

Figure 7--Fireline intensity for the commercial thinning 1-year-old lodgepole pine residue loadings (foliage and branchwood less than 3 inches diameter) by 5 mi/h windspeed intervals at 20 feet above ground. The shaded band indicates the lower limits of difficult fire suppression.

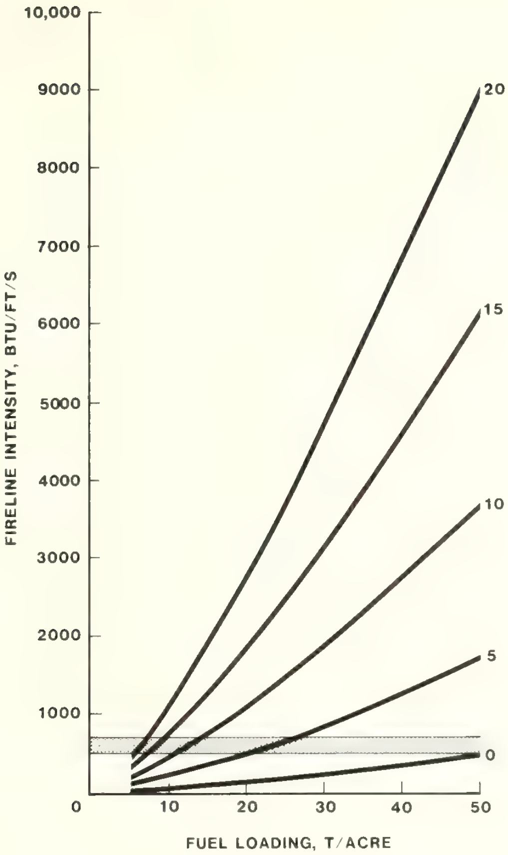

Figure 8--Fireline intensity for the precommercial thinning option 1-year-old lodgepole pine residue loadings (foliage and branchwood less than 3 inches diameter) by 5 mi/h windspeed intervals at 20 feet above ground. The shaded band indicates the lower limits of difficult fire suppression.

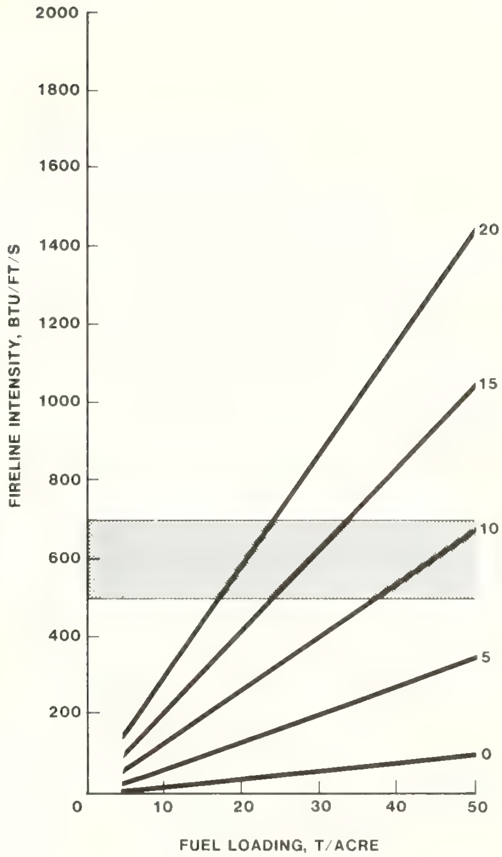

Figure 9--Fireline intensity for the precommercial thinning option 5-year-old lodgepole pine residue loadings (foliage and branchwood less than 3 inches diameter) by 5 mi/h windspeed intervals at 20 feet above ground. The shaded band indicates the lower limits of difficult fire suppression.

Certainly, windspeeds of 4 and 12 mi/h occur frequently and a windspeed of 17 mi/h occurs occasionally in most areas. Thus, the 20 tons per acre fuel loading represents hazardous fire behavior potential on some to many days during the summer. Hazard at higher loadings, of course, is increased (figs. 7, 8, and 9).

In commercial thinning, removing trees 3 inches in diameter and larger at stump height reduced predicted fireline intensity to half of the potential if all residues had remained on site. However, the removal of trees still left potential fireline intensities that exceeded capabilities for direct fire suppression at commonly occurring windspeeds. In whole-tree skidding of commercial-size Douglas-fir and western larch, fireline intensity was reduced approximately four times from the potential created by all fuels remaining on site (Brown 1980).

In precommercial thinning, loadings of less than 3-inch fuel that are less than 15 to 20 tons per acre will be below hazardous levels in about 5 years (fig. 9). Appraisal of 5-year-old slash may be most appropriate for deciding upon hazard abatement activities because the fire behavior potential will likely persist for 20 or more years. Although hazard is greater in 1-year-old slash, it only persists at higher levels for 1 to 3 years.

Applying figures 7, 8, and 9 to harvested, small-stem lodgepole pine stands requires judgment. The commercial thinning option best represents fuelbed compactness created by directional felling and slashing of unremoved stems. It should provide reasonable estimates for 1- and 2-year-old slash (fig. 7). Figure 8 should apply best to 1- and 2-year-old precommercially thinned slash. However, for appraising all slash 5 years and older, the precommercial thinning option should be assumed (fig. 9). Accuracy of predicted fireline intensity for 5-year-old slash under the commercial thinning option is uncertain. We suspect that the commercial thinning option would probably substantially underpredict fireline intensity. Certainly, total fire intensity, which includes flaming combustion within and behind the propagating fire front, would probably greatly exceed predicted fireline intensity. The mathematical model used to predict fireline intensity was based on combustion of fine fuels (Rothermel 1972). After foliage has fallen, a fuelbed of small-stem lodgepole pine slash is largely composed of tightly compacted woody fuel greater than one-half inch in diameter. Prolonged

burnout of woody fuel results. These fuel conditions are beyond the scope of current fire behavior modeling. Predictions of fireline intensity in tightly compacted fuelbeds are untested.

Few trees would survive fire in harvested, small-stem lodgepole pine stands. For example, at 300 Btu/ft/s, which is easily reached (figs. 7, 8, and 9), a 5-inch d.b.h. lodgepole pine tree has less than a 10 percent chance of surviving fire (Reinhardt and Ryan in press). Smaller trees would have essentially no chance of surviving fire and larger trees only a slightly better chance.

EXPECTED FIRE SIZE

Expected fire size provides a means to compare fuel treatment effectiveness. Determining expected fire size is a necessary step in evaluating the effect of fire on resource production and for assessing operational costs.

Removal of fuel by commercial thinning and directional felling effectively reduced expected fire size from that of precommercial thinning (table 4). Expected fire size in commercially thinned 1-year slash with directional felling was substantially less than that with random felling for moderate loadings, but not for heavy loadings. However, at heavy loadings in 5-year slash, directional felling resulted in a smaller expected fire size than random felling. In 5-year slash at moderate loadings, there was no difference between felling methods. For several commercial thinning situations, expected fire size was reduced to undisturbed levels within 5 years (table 4).

Nominal lopping reduced fireline intensity, but not enough to affect difficulty of fire suppression. For example, lopping reduced fireline intensity to below 700 Btu/ft/s only at windspeeds of less than 5 mi/h for the precommercial thinning model at moderate fuel loading. Thus, at windspeeds greater than 5 mi/h,

Table 4--Expected fire size determined for cutting and undisturbed fuel treatments. Abbreviations are: PC--precommercial thinning and C--commercial thinning. Numbers in parentheses are expected fire sizes normalized to Fuel Model 8

		Slash age and loading				
		1-year		5-year		
Fuel model	Lopping	Moderate	Heavy	Moderate	Heavy	Nonslash
		Acres				
Cutting						
PC, random fell	no	181 (6.5)	184 (6.6)	117 (4.2)	126 (4.5)	
PC, random fell	yes	174 (6.2)	184 (6.6)	117 (4.2)	126 (4.5)	
C, random fell	no	115 (4.1)	126 (4.5)	28 (1.0)	61 (2.2)	
C, random fell	yes	106 (3.8)	117 (4.2)	28 (1.0)	61 (2.2)	
C, directional fell	yes[1]	47 (1.7)	109 (3.9)	28 (1.0)	28 (1.0)	
Undisturbed						
Model 10						106 (3.8)
Model 8						28 (1.0)

[1]More compact than nominal lopping because stems are slashed every 6 feet and branches 1 inch or greater in diameter are lopped.

difficulty of fire suppression was not significantly changed.

For precommercial thinning and some commercial thinning situations, expected fire size was nearly the same at heavy and moderate fuel loadings. In other commercial thinning situations, expected fire size differed between moderate and heavy loadings due to method of felling (table 4).

The accuracy of fire size predictions in this analysis is unknown. Estimates are probably high for harvesting in small-stem lodgepole pine, primarily because it was assumed that all fires were burning during midday when weather readings are normally taken. Some fires, however, start at night and are put out before afternoon. Nonetheless, the relative differences in fire size between harvesting treatments should be meaningful.

METHODS FOR APPRAISING SLASH HAZARD

Procedures for estimating fuel quantities and fire behavior potential are available for appraising slash hazard on specific land units. Land managers who wish to appraise slash hazard should first decide how accurately they need to know fuel quantity and fire behavior potentials. Then, one of the following methods can be used to help appraise slash hazard.

1. Nomographs of rate of spread, fire intensity, and flame length--Using nomographs developed by Albini (1976), fire behavior at variable fuel moisture and windspeed can be predicted for low, medium, and heavy logging slash. These nomograms were developed for slash left after logging to an 8-inch top and skidding using a ground-lead system. Precision in the fire behavior estimates is relatively broad since the method recognizes only three levels of fuel quantity.

2. Photo series--A series of photographs depicting a wide range of slash conditions identified by estimates of fuel loadings and fire behavior ratings was developed by Koski and Fischer (1979) for thinning slash in northern Idaho, and by Maxwell and Ward (1978a, 1978b) for forest residues in Washington and Oregon. These photos in field manual editions can be compared with existing slash accumulations. By selecting the photo that most nearly compares with what is seen on the ground, one can estimate fuel loading and fire behavior potentials. This method affords more resolution of predictions than the nomograph method, but its accuracy is unknown and probably somewhat limited. The method is appropriate where the more accurate methods are not available or needed.

3. Computer analysis using program HAZARD--Estimates of head-fire spread rate, perimeter growth rate, flame length, crown scorch height, fireline intensity, and other fire characteristics can be obtained using computer program HAZARD, which can be accessed through the USDA Computer Center at Fort Collins, CO. Procedures for making the hazard assessment are described in Fuel Treatment Guides, published by the Northern Region (Puckett and others 1979) and Pacific Northwest Region (Snell and others 1979) of the Forest Service.

Operation of the HAZARD program requires estimates of down woody fuels existing before cutting, and debris expected from cutting. If necessary, existing fuels can be inventoried using the planar intersect method (Brown 1974). (In the Northern Region, the same information can be obtained from the down fuel inventory done in conjunction with the Northern Region Stand Examination). Expected quantities of debris can be estimated using tables developed by Brown and others (1977) or by using a computer program called QDEBRIS. This program furnishes predictions of debris from timber stand inventories and from Northern and Pacific Region sale cruises.

Of all current methods, HAZARD provides maximum resolution and accuracy with the least amount of user interaction. Program HAZARD has built in functions that determine proper fuel depth and effects of slash aging.

4. Computer analysis using BEHAVE--BEHAVE is an interactive computer system for predicting fire behavior characteristics (Andrews 1986). The complete system, which includes fuel modeling, is available on most Forest Service Data General computers at the National Forest level, and at the USDA Fort Collins Computer Center. BEHAVE will estimate fire spread rate, intensity, probable flame length, containment time, and final fire size. To do this requires information about fuels, weather, time, overstory, fuel moisture, and position of the fire on a slope. BEHAVE features a method to aid in development of site-specific fuel models if the 13 standard fuel models cannot be used (Burgan and Rothermel 1984).

5. Computer analysis using the national fuel appraisal process-- This is a quantitative process for appraising fire hazard of residue fuels. This process combines fire and fuel modeling with decision analysis principles to produce an estimate of expected burn area. Expected fire occurrence, climate, fuel loads, fire behavior, and suppression capability are considered in the fuel appraisal process. The process has 12 steps described in a User's Guide to the National Fuel Appraisal Process (Radloff and others 1982). This appraisal process, related to Forest Service activities, is also described in the Fire Management Analysis and Planning Handbook (USDA Forest Service 1985).

SELECTING A FUEL TREATMENT OPTION

An important and often difficult question is what fuel treatment options, including no treatment, are justified? The question is basically are the benefits of fuel removal, mechanically or by fire, greater than the costs? The answer depends on many site-specific factors. An approach to answering the question by systematically evaluating how much fuel is acceptable is suggested by Brown (1980). The process requires

systematic consideration of fire behavior potential over treated and surrounding untreated areas, effects on resource values, management objectives, pattern of land ownership, and suppression capability.

ECONOMIC ANALYSIS

A method of analysis subscribed to in several studies of fuel treatment options and described in the Fire Management Analysis and Planning Handbook (USDA Forest Service 1985) involves determining fire program costs plus net resource value change. This analysis requires knowledge of expected annual area burned for all fuel treatment options, costs of the fire program with and without fuel treatment, and values of resources with and without fuel treatment.

Using this type of analysis to evaluate management of nonslash fuels in the Lolo National Forest, Wood (1979) concluded that fuel treatment to protect the timber resource alone (by reducing the number of class E and bigger fires) was not economically feasible. In a detailed analysis of fuels, fire behavior, and expected burn area for a ponderosa pine forest in Arizona, Hirsch and others (1979) found that treatment of only sawtimber slash was preferred. Only timber values were considered. They also noted that incorporating more resource values could change the selection of a fuel treatment. In a case study of fire management and fuel treatment decisions involving commercially valuable Douglas-fir in the Mount Hood National Forest, Barrager and others (1982) found that, under a wide range of assumptions, no fuel treatment was the best alternative. They drew two possible conclusions:

1. Direct resource benefits of fuel treatment such as enhanced water, wildlife, and other resource values are underestimated, or;
2. Much more fuel treatment is being carried out than is economically feasible.

These studies have shown that (1) benefits other than commercial timber products can strongly influence the outcome of economic analyses, and (2) fuel treatment may be justified on high-value timber sites but is difficult to justify on low-value sites.

Although none of these studies dealt specifically with harvesting small-stem lodgepole pine, they do suggest that fuel treatment in partially cut lodgepole pine stands would be difficult to justify economically, primarily because of low timber values and low fire occurrence rates.

Analyses of costs plus net value change provide an objective basis for deciding upon fuel treatment options. Limitations to these analyses usually involve the inability to objectively describe all important factors. One factor that is difficult to evaluate is the chance of a very large fire with uncertain threat to lives. Regardless of the degree of quantification in evaluating fuel treatment options, experience and judgment are required for both technical considerations and to interpret social/political concerns.

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EFFECTS OF THINNING SMALL-STEM LODGEPOLE PINE STANDS ON BIG GAME HABITAT

L. Jack Lyon

ABSTRACT: Acceptable habitat for Rocky Mountain elk is generally considered to require combinations of hiding cover, thermal cover, and foraging areas. In this study, untreated lodgepole pine stands provided high levels of hiding and thermal cover. Thinning at any level reduced these values; with 66 percent basal area removal, the losses were substantial. Based on the predicted growth of treated stands, thermal cover values will eventually be regained, but hiding cover will not. The 66 percent treatment could possibly result in an understory response that will increase forage production; but the 33 percent and untreated stands are unlikely to have productive understories. Evaluation of these changes on habitat quality for elk would require information about stand juxtaposition and arrangement.

INTRODUCTION

Thinning timber stands, although it will not usually produce as complete a change in the forest environment as final harvest logging, nevertheless is recognized as having potentially important influences on the quality and productivity of forest wildlife habitats. Evaluating those influences will not produce any equivocal judgment in a positive or negative sense. Some results are likely to be beneficial, while others will certainly be negative. In this presentation, I discuss some possible effects on big game habitat of thinning in small-stem stands of lodgepole pine.

In recent years, methods of evaluating habitat quality for big game animals have become increasingly precise because managers have been able to evaluate existing habitat against relatively standard criteria that represent high-quality habitat. The Rocky Mountain elk has achieved prominence as a representative big game species because elk habitat models are generally similar to each other and are widely used by western National Forest personnel. Although there are variations in the ways model results are used and interpreted, there is a consistency in the fact that all models presume the necessity for hiding cover, thermal cover, foraging areas, and for appropriate juxtaposition of cover areas and foraging areas.

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L. Jack Lyon is Project Leader for Wildlife Habitats Research, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT.

HABITAT DEFINITIONS

Acceptable habitat for Rocky Mountain elk is generally considered to require combinations of hiding cover, thermal cover, and foraging areas. An optimal arrangement might include ". . . 20-percent hiding cover, 10-percent thermal cover, 10-percent hiding or thermal cover, and 60-percent forage areas" (Thomas and others 1979, p. 121). The values of interest are defined as:

> Hiding Cover--vegetation capable of hiding 90 percent of a standing adult elk from the view of a human at a distance of 200 feet or less.
>
> Thermal Cover--any stand of coniferous trees 40 feet or more in height and with an average canopy closure exceeding 70 percent.
>
> Foraging Area--any vegetated area that does not satisfy the criteria for cover.

Using these definitions, one can take a relatively straightforward approach to evaluating the influence of thinning in individual small-stem timber stands. The presumptions made are that management activities in an existing timber stand modify the cover values of the stand and may possibly convert the stand to a foraging area.

DATA EVALUATION

Data from 60 lodgepole pine stands examined in the Systems of Timber Utilization for Environmental Management (STEM) study were used in developing estimates of hiding and thermal cover. Included were stands thinned to 33 and 66 percent of previous basal area and untreated stands. Evaluation procedures were:

Hiding cover--In mature lodgepole pine stands, the hiding cover value is primarily determined by visual obstruction by individual tree stems. This value can be calculated with the computer program HIDE2 on the Forest Service Northern Region mainframe computer or in a BASIC version for IBM-compatible personal computers, (Lyon 1985). Input to the program is the stand structure indicated by stem diameters and densities. Output is the calculated percentage of hiding cover for elk. When this estimated value is less than 90 percent, it indicates some cover, but less than required to classify the entire stand as hiding cover.

Thermal cover--Actual canopy cover in the sample stands was not measured during the STEM study, but

several options were available for calculating the canopy closure values. For pretreatment stands, I used the basal area formula developed for lodgepole pine by Dealy (1985):

$$\text{Percent crown closure} = -20.29+41.80(\text{Log10}(BA+1))$$

For the immediate posttreatment stands, when crown diameters were still likely to have been influenced by pretreatment densities, I used the average crown diameter and density figures supplied by the STEM study. And for posttreatment stands predicted at 120 years, whether treated or untreated, I used Dealy's formula.

Foraging area--Any stand that does not provide 90 percent hiding cover or have 70 percent canopy closure is, by definition, a foraging area. However, there may be some hiding and thermal values present in many stands that do not fully satisfy these criteria. Where some cover values remain, forage production usually is reduced in proportion to the amount of cover remaining. It is also generally recognized that many of the forest types in which lodgepole pine is dominant do not necessarily produce substantial understory responses when crown cover is reduced.

DATA ANALYSIS

Analyses consisted primarily of determining mean values and ranges for hiding cover and thermal cover for stands in various treatment categories. In addition, each data set was examined with the regression program REX using basal area, stem density, and stem diameter as predictors of cover values. REX computes all possible combinations of the three variables and selects the combination that yields the smallest residual mean square. Interpretation of this analysis is obviously confounded by the strong correlations among the three variables, but a useful purpose is nevertheless served if the range of predicted cover values is not overly narrow. For most treatments it was possible to determine the minimum set of values adequate to satisfy cover definitions.

RESULTS

Pretreatment data were available for 60 stands. In 30 stands treatment was completed and predictions of future growth were made. Appropriate estimates of hiding cover and thermal cover were made for four categories of data: pretreatment; immediate posttreatment; treated, 120 years; and untreated, 120 years. The projection to 120 years was selected as adequately representative of growth responses expected in these stands. Means presented in table 1 represent all replications of the same treatment for both hiding cover and thermal cover calculations.

Hiding Cover

Pretreatment--Stem density was under 1,000 per acre in only two of the untreated stands and under 2,000 per acre in an additional six stands. For these eight stands, hiding cover averaged 57.7 percent. No stand with 2,300 or more stems had less than 90 percent hiding cover. The minimum values required to supply hiding cover were about 160 ft^2 basal area and 2,300 stems per acre.

Table 1--Hiding cover and thermal cover values calculated for lodgepole pine stands of the STEM study

Treatment category	Samples	Hiding cover	Thermal cover[1]
	Number	Percent	Percent
Pretreatment	60	93.3	75.8
Immediate posttreatment			
33 percent	15	48.0	54.9
66 percent	15	11.9	29.2
Treated, 120 years			
33 percent	15	48.8	70.8
66 percent	15	24.0	66.6
Untreated, 120 years	30	77.5	73.0

[1]Mean crown widths of residual trees were measured in most plots. Averages for 33 and 66 percent posttreatment canopy cover were 5.1 and 5.7 feet, respectively. For pretreatment and predictions, canopy closure was calculated by formula (Dealy 1985).

Posttreatment--Following removal of 33 percent basal area, an average of 48.0 percent hiding cover remained. This figure is somewhat deceiving, however, because actual cover values in the treated stands ranged from 9.7 to 97.8 percent. At least 110 ft^2 of basal area and 1,100 stems per acre are required to retain even 50 percent hiding cover. Removal of 66 percent basal area was relatively consistent in reducing hiding cover to an average 11.9 percent, although treatments in which 1,000 stems per acre remained had about 30 percent cover.

Predicted--The average stem diameter with 33 percent removal is predicted to rise from 4.5 to 6.3 inches, but tree densities will decline from about 1,200 to 800 per acre. Hiding cover in these stands will average 48.8 percent. In the 66 percent removal stands, hiding cover is predicted to rise to approximately 24 percent at 120 years. With the increase in average stem sizes in these stands, a minimum basal area of 160 and density of 900 stems per acre are required to produce 50 percent hiding cover.

In the absence of any treatment, hiding cover is predicted to decline to approximately 78 percent. However, this prediction is based on live stems only. There is a relatively high expectation that standing dead stems would actually produce hiding cover values approximating those of the pretreatment stands.

Thermal Cover

Pretreatment--Crown canopy closure in the untreated stands ranged from 60.7 to 86.5 percent, but only 12 stands were under 70 percent and just one under 65 percent closure. Any basal area greater than 140 is likely to have 70 percent or greater canopy closure and thus satisfy thermal cover standards.

Posttreatment--Reductions in canopy cover to about 55 percent following 33 percent basal area removal, and to 29 percent following 66 percent basal area removal, were relatively consistent in all treated stands. Any basal area greater than 128 ft^2 will have at least 50 percent thermal cover remaining, but the immediate posttreatment stands will only rarely have as much as 70 percent canopy.

Predicted--When enough time has passed for tree crowns to fill out into the space made available by thinning, stands of the 33 percent treatment will average about 71 percent canopy and the 66 percent treatment stands will reach 67 percent canopy. In either treatment, 148 feet of basal area is predicted to produce 70 percent crown closure. Stands with lesser basal areas will have much lower canopy closure values.

Treated and untreated stands would become virtually identical over the range of time used for this prediction. Data for the untreated stands suggest that any basal area greater than 146 ft^2 will produce 70 percent crown closure at 120 years.

Foraging Areas

No data were available to provide a direct demonstration of forage production changes in the stands of the STEM study. Nevertheless, some evaluation of probable foraging values is suggested by the crown canopy information and at least partially confirmed by field inspection. Before treatment, virtually every stand had 70 percent or greater canopy closure. Any treatment providing more light to the forest floor could be expected to increase understory production--but only in situations where an understory plant community already exists. It should be recognized that thinning, unlike complete removal, provides little disturbance and little opportunity for establishment of new plants. Where a duff and needle cover and few understory plants are present, no increases in forage production can be expected.

Based on averages, only the treatments with 66 percent basal area removal were considered likely to increase forage production. Lesser treatments did not reduce canopy closure below 50 percent, and understory responses to such minor increases in light are likely to be too subtle to be detected. Moreover, even the 66 percent treatment left enough tree crowns to block out a fourth of the available light.

Other Considerations

Shrubs as hiding cover--Tall shrubs appeared to provide hiding cover where they were present. However, only three stands in the STEM study had tall shrubs. The data presented in table 2 make it clear that presence of any shrub species tall enough to provide hiding cover in lodgepole pine stands can make an important contribution. At the shrub densities recorded, hiding cover was increased to over 90 percent in virtually every treatment situation.

Slash disposal--A final consideration in evaluating the influence of thinning on habitat quality for big game involves the disposal of the cut materials. In the STEM study, all of the cut material over 3 inches in diameter was removed. Some was utilized for grape stakes, corral poles, or other purposes. When such material is not removed or treated, it can become an obstruction to big game use of the thinned stands. Lyon and Jensen (1980) showed that 1.5 feet of untreated slash in clearcut openings will reduce elk use by 50 percent. Similar, or even greater, losses of potential use by big game can be expected when slash remains in thinned stands. Failure to remove slash will also result in substantial reductions in expected production by understory plants.

DISCUSSION

Older lodgepole pine stands generally achieve status as cover for big game on visual blockage by stems alone. Any stem density greater than 2,300 per acre or basal area over 160 ft^2 probably represents hiding cover; any basal area greater than 140 ft^2 almost certainly has the 70 percent crown closure required for thermal cover.

Removal of stems from these stands reduces hiding cover and thermal cover values and may increase forage production. Hiding cover, in particular, can relatively easily be reduced to less than acceptable levels for big game. Any influence these changes might have on the quality of big game habitat, however, is determined by the already existing proportions of hiding cover, thermal cover, and foraging areas in the environment. Where cover is in excess, conversion of dense stands of trees to more productive foraging areas has some potential for improvement of habitat quality. Successful conversion depends on selecting stands with already existing understory vegetation and removing enough of the thinned material to assure the treated stand will not be avoided by game animals.

Table 2--Hiding cover contribution of shrubs in three lodgepole pine stands of the STEM study

Area and shrub component	Hiding cover: Without shrubs	Hiding cover: With shrubs
	Percent	
Ballard Hill North: 48 Willow, 48 Alder		
Pretreatment	98.9	100.0
Posttreatment plus 8 years		
33 percent	75.9	94.8
66 percent	5.2	79.3
Treated, 120 years		
33 percent	56.9	89.7
66 percent	19.0	86.2
Untreated, 120 years	81.1	96.6
Echo Lake: 16 Willow, 89 Alder		
Pretreatment	100.0	100.0
Posttreatment plus 8 years		
33 percent	67.2	96.6
66 percent	12.1	93.1
Treated, 120 years		
33 percent	62.1	94.8
66 percent	39.7	96.6
Untreated, 120 years	99.2	100.0
Dry Creek West: 138 Maple		
Pretreatment	100.0	100.0
Posttreatment plus 8 years		
33 percent	44.8	100.0
66 percent	5.2	93.1
Treated, 120 years		
33 percent	43.1	96.6
66 percent	39.7	93.1
Untreated, 120 years	88.0	99.2

These calculations were based on the assumption that average plant width is determined by the shrub species tolerance in competition for light. Five overstory conditions assumed the following average shrub widths (in feet):

Species	Pre-treatment	Post-treatment	Treated 33%	Treated 66%	Untreated
Willow (SASC)	2	5	2	3	2
Alder (ALSI)	8	4	6	6	8
Maple (ACGL)	3	5	4	5	3

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ECONOMIC EVALUATION OF ALTERNATIVE LODGEPOLE PINE STAND TREATMENT EFFECTS ON TIMBER AND NONTIMBER RESOURCES

Robert E. Benson

ABSTRACT: More than 30 cutting units in 15 lodgepole pine pole-size stands were used as a basis for analyzing the economic and other management consequences of alternative harvesting practices. Net dollar values are an important part of such economic analyses, and these values were computed for the study sites. Observed treatment costs and recovered values, and several simulations, were used with projections of future stand growth in the analyses. Although most stand treatments were economically marginal or submarginal, some showed positive future values. Wildlife habitat and scenic quality were significantly influenced by stand treatments, with heavier cutting levels generally being least desirable.

INTRODUCTION

As part of the Systems of Timber Utilization for Environmental Management (STEM) program of research in harvesting and utilization alternatives for marginal timber resources, young overstocked stands of lodgepole pine were treated using 33 percent and 66 percent basal area reduction partial-cut prescriptions, as well as clearcutting. This paper evaluates the economic aspects of these harvesting alternatives, and the relationship to timber and nontimber resource management considerations.

Of 25 areas identified as representing young, overstocked lodgepole pine stands in the Northern and Intermountain Forest Service Regions, 23 areas were contracted for harvesting. Of these, 15 areas composed of 33 treatment subunits were completed in time for this initial summary of harvesting. Eleven areas, with 25 treatment subunits, had harvest cost and recovered product value data that were suitable for analysis of timber values. The other eight harvested subunits contributed volume and stand stocking data that are used in some parts of the analysis that follows. The analysis of timber and nontimber resource effects includes consideration of esthetics, wildlife habitat, and potential growth and losses in stands that have been thinned.

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Robert E. Benson is Research Forester, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT.

ANALYSIS OF TIMBER VALUES

The stands harvested at the study sites are representative of many situations where posts and poles are commercially harvested. However, research study requirements resulted in several important operational differences. Thinning was based on applying prescribed percent reductions in preharvest basal area, removing smaller trees and leaving dominant-codominant trees in the residual stands. As a result, there was wide variation in the amount and type of material removed, and in postharvest spacing of the residual stands. All cut material 3 inches and larger at the stump, live or dead, was required to be removed from the stand even if it was not considered merchantable by the operator. No mechanical equipment was allowed inside the stand for skidding; most material was removed by hand or bunched by hand and line skidded to a landing outside the stand.

The required removal of all cut stems 3 inches and larger at the stump was intended to encourage maximum product recovery by operators. Any stem 3 inches in stump diameter will usually yield a "grape stake" or agricultural stake product, and therefore is "commercial" for roundwood product utilization. However, because of poor local market demand and the long distance from many of the units to a viable market, product recovery was limited. Several operators preferred or chose to simply pull the required material from the stand and stack it for disposal. Consequently, the analysis is based on costs that include removal of much material not utilized for products (even though potential products existed). To provide a clearer picture of economic feasibility, actual treatment cost and product recovery information is supplemented by estimated costs if only recovered products are removed, and by estimating potential rather than actual product recovery. The best estimate of economic feasibility for a stand is obtained by comparing costs involving only recovered product removal to values of potential product recovery.

Because material removal requirements affect harvest costs and product recovery, the analysis of costs and values focuses on three questions:

1. What was the actual cost of harvesting and product value recovered under prescribed study conditions?

2. What is the probable treatment cost and potential value of products recoverable for the kind of stands represented, if removal of cut material is optional rather than required?

3. How are costs affected by characteristics of the stand or harvest operation?

Stand Treatment Costs

Average actual stand treatment costs are summarized by harvest treatment in table 1. Actual treatment costs averaged $949 per acre in the 33 percent reduction units, $1,756 in the 66 percent reduction units, and $3,671 in the clearcut units. In individual harvest units, costs ranged from $317 per acre up to $3,986. These costs were developed using man and machine operating hours reported by operators (Hawkins this proceedings), multiplied by wage and machine rates judged to be about average for post and pole operators.

Table 1--Average actual treatment cost and estimated cost for thinning and product removal (stems >3 inches at stump) only, by treatment prescription[1]

Treatment	Actual cost, thinning and total removal of stems	Simulated cost, thinning and product removal only	Difference
	Dollars per acre		
Basal area reduction (33 percent)	949	733	216
Basal area reduction (66 percent)	1,756	1,138	618
Clearcut[2]	3,671	2,032	1,639

[1]Based on 25 units for which cost and value data are available.

[2]Because of inadequate data, one clearcut area is not included in these averages.

Table 1 also shows a set of estimated costs (column 2), calculated by assuming that after felling the trees the operator removed only those considered as commercial products. As might be expected, these costs are considerably less than actual treatment costs because removal costs for the other (nonproduct) material were quite high, given the research study requirements imposed. The "difference" column in table 1 is an estimate of how much more it cost to achieve the removal of additional or nonmerchantable material. A detailed analysis of the harvest operations and logging productivity is presented by Hawkins (this proceedings).

Cost data also were analyzed to consider variations in stand and other operating conditions. Regression analysis was used to estimate the effect on costs of such things as number of trees cut, tree size, and volume removed. Several models were tested that reflected different aspects of costs (felling, removal, and total costs per acre).

Although several statistically significant variables were identified in these analyses, they are not reported in detail here. In our judgment, the limited number of observations and extreme variations in the harvesting practices of individual operators make interpretation inconclusive and subject to conjecture. Several points from the analyses are worth noting, however. Felling costs averaged $815 per acre and (by coincidence) removal costs were also $815 per acre. This ratio is consistent with data from several other studies of harvesting small stems in which these two components each averaged about 40 percent to 60 percent of stump-to-landing costs. Felling costs per acre increased as the number of 3- to 7-inch diameter at breast height (d.b.h.) stems cut per acre increased. These stems were required to be removed, and generally were measured, limbed, and bucked into product pieces; these steps are included in felling costs.

In contrast, felling costs per acre were relatively low for stands that had a very high total number of stems per acre because many of these stems were less than 3 inches d.b.h. and required only felling. Felling costs per acre were also lower as volume per tree increased, reflecting the fact that larger trees generally mean fewer trees per acre. Removal costs varied widely among study units, and although larger volume per stem was associated with lower cost per acre, there was no significant relationship between costs and volumes or number of stems per acre removed.

Product Values

Actual product values recovered by operators averaged $314 per acre for the 33 percent reduction units, $714 for the 66 percent reduction units, and $1,461 for the clearcut units. The range for individual units was 0 to $2,130 per acre. Average values recovered for each treatment are summarized in table 2.

Table 2--Summary of actual and adjusted product values, by treatment prescription[1]

Treatment	Actual value recovered	Simulated stand value	Difference
	Dollars per acre		
Basal area reduction (33 percent)	258	451	193
Basal area reduction (66 percent)	588	1,082	494
Clearcut	1,209	1,635	426

[1]Source: Hawkins this proceedings.

Because of local market constraints and lack of interest by the contractors, product recovery was often substantially less than it could have been. Also, values can be affected by current local supply and other factors not directly related to the stand. To adjust for these variations and provide a more uniform basis for comparing potential current and future stand values, a product recovery model was used (Hawkins and Schlieter this proceedings) to derive an estimate of potential value available from each site. Tree form, size, and defect information developed from study sites was used in the model, and was combined with standard product specifications and average product prices to derive the adjusted value estimates also shown in table 2. The "difference" column is a measure of the added product recovery and value that operators failed to obtain. Erratic markets and lack of initiative by some operators undoubtedly accounted for a large part of this forgone product value.

The actual net values from the study (actual values minus actual costs) ranged from +$735 per acre for one unit to -$3,124 for another. Because of wide variations in costs and values that may have been due in part to study constraints and operator characteristics, the adjusted or simulated costs and values shown in tables 1 and 2 (column 2) may provide a better comparison of potential net values. On this basis, the estimated net value for the 33 percent removal averaged -$282 per acre, for the 66 percent units -$51 per acre, and for the clearcut units -$397 per acre. In my opinion, however, the values for the clearcut units are not representative because unnecessarily expensive equipment and operating procedures were used on some areas, resulting in abnormally high costs. In the 33 percent removal treatments, 3 of the 11 units had positive or near break-even net values; in the 66 percent treatment, 6 of the 11 units had positive or near break-even net values. For the areas included, it appeared that the net values were more favorable for the heavier thinning, probably because there were more larger merchantable stems available to offset the costs of cutting nonmerchantable dead and small stems.

Projected Future Timber Values

Growing time following harvest in 1983-84 was not long enough to make growth response measurements on residual stands created by the treatments. Therefore, to bring expected future stand values into this analysis, treated stands were "grown" through time using the LPGRO model (Cole this proceedings). This model is based on stand age, site, and stocking and provides a quantitative and systematic estimate of future stand growth that can be used as a basis for comparing treatments. Actual stand response may, of course, vary from predicted values because of many uncertainties. Projections, therefore, were kept as simple as possible and were intended to answer the following questions:

1. What will be the net value of thinned stands if they are held for about 40 years without further intermediate thinnings?

2. What would be the value of these stands if they were harvested at the culmination of mean annual increment (MAI) when this is projected to occur at more than 40 years in the future?

3. What would be the value of these stands if instead of being thinned now they were held for 40 years without thinning and then harvested?

Future timber values, management objectives, and costs may change over time, but a basic measure of future stand values was assumed. Expected future volumes were converted to net values using costs estimated from various studies and appraisal guides, and wood prices of $125/1,000 bd ft of sawlogs and $\$0.50/ft^3$ for smaller material used for roundwood products (1983 dollars).

Projected future costs and values are summarized in table 3. The 33 percent reduction units have a projected net value of -$280/acre in 40 years. If these stands were allowed to reach culmination of MAI, however, they are nearer to a break-even operation than if harvested 40 years hence. The 66 percent reduction units are projected to have a positive net value in either case. If the stands were allowed to grow to culmination of MAI, they would have nearly four times the net value they would have if harvested 40 years hence. The culmination of MAI for both treatments would occur about 55 years hence on average. In both cases, the gain is in the projected values, which increase more than the increase in harvest costs.

Table 3--Projected future harvest costs and value of thinned stands at 40 years in the future or at culmination of mean annual increment (MAI) (in 1983 dollars)

Unit thinning level and projection	Product value[1]	Harvesting cost[2]	Net
	Dollars per acre		
33 percent basal area reduction units:			
40 years	2,353	2,633	-280
MAI	2,655	2,758	-103
66 percent basal area reduction units:			
40 years	1,981	1,886	+95
MAI	2,571	2,205	+366

[1]Estimated at $125/1,000 bd ft sawlogs and $\$0.50/ft^3$ for smaller roundwood products.

[2]Estimated from various harvest cost data. Detailed data on file at Forestry Sciences Laboratory, Missoula, MT.

In table 4 these units are projected as if no thinning had occurred now, but rather they were harvested in 40 years or at culmination of MAI. Culmination of MAI was generally 50 or 60 years hence. In this simulation, all the projected net values are negative by about the same amount (-$800 to more than -$900/acre).

Table 4--Projected future harvest costs and values of thinned stands, if no thinning had occurred and the stands were clearcut 40 years in the future, or at culmination of mean annual increment (MAI) (1983 dollars)

Unit thinning level and projection	Value	Cost	Net
	- - - Dollars per acre - - -		
33 percent basal area reduction units:			
40 years	2,645	3,559	-914
MAI	2,690	3,578	-888
66 percent basal area reduction units:			
40 years	2,552	3,496	-944
MAI	2,677	3,509	-803

The stand projections used in these analyses were developed by Hungerford (this proceedings). The relationship of stocking, volume, and growth for a typical unit (Corduroy Creek East) is shown in figure 1. In this example, in 40 years the projected merchantable volume if unthinned (6,070 ft^3/acre) would be greater than in the projected thinned stand (4,760 ft^3/acre). However, the net value of the thinned stand is greater because the merchantable volume is concentrated on fewer stems. Values are greater and harvesting costs are reduced considerably, resulting in a net value of +$208/acre at 40 years hence as compared to -$670/acre for the unthinned stand. In addition, the thinned stand reaches culmination of MAI in 60 years, and would have nearly twice the net value as the thinned stand would have in 40 years.

The previous tables and discussion have summarized the costs and values that might result from the studied harvesting alternatives in overstocked lodgepole stands. These alternatives can be compared by combining the current and projected future values as shown in table 5. The current values shown are derived from tables 1 and 2. The future net values are from tables 3 and 4, using the net values for harvesting stands at culmination of MAI (harvest in 40 years could have been used). These net values were then discounted to the present using a 4 percent discount rate.

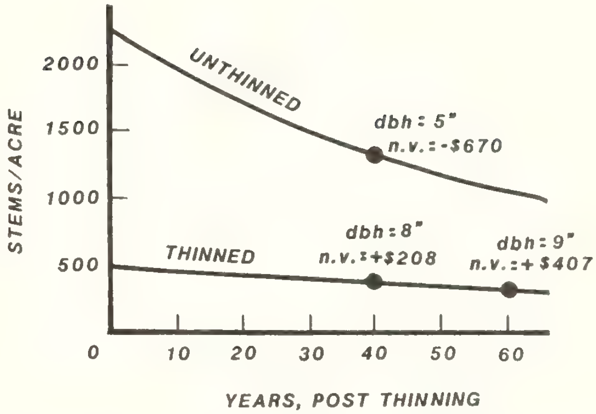

Figure 1--Projected stocking, average d.b.h., and net value for typical thinned and unthinned lodgepole pine stands.

Table 5--Summary of net dollar values for alternative treatments of sample stands, using simulated costs and values. Thinning or harvest at culmination of mean annual increment (MAI)

Study treatment and projection	Current net value	Discounted present value of future stand net value	Total current discounted net value
	- - - - Dollars per acre - - - -		
33 percent basal area reduction units:			
Thinned	-282	-30	-312
Not thinned	0	-125	-125
66 percent basal area reduction units:			
Thinned	-56	+29	-27
Not thinned	0	-79	-79
Clearcut units	-397	[1]0	-397

[1]Units clearcut now would have some young growing stock stands established, but their management and projected values are not included in this analysis.

This summary indicates that although none of the alternatives has a positive discounted current

net value, the 66 percent units are nearest to being a break-even operation. Because this average represents considerable variation in both current and projected future net values, even the "best" options may or may not be considered economically viable on an individual stand basis.

These net values illustrate that current harvests and expected future harvests should be approached as two separate parts of the problem of managing these stands. The differences in initial thinning values and the expected response and future net values may pose a tradeoff for managers to consider in setting a level of thinning and in specifying harvesting requirements such as slashing or removal of nonmerchantable material. Part of that management decision will probably involve considerations other than harvesting and product values.

NONTIMBER CONSIDERATIONS

At the start of the STEM program, managers indicated their concern over how to manage overstocked lodgepole to produce timber crops, and the costs of doing so. They also cited the need to protect or improve nontimber resources and to incorporate in decision making related management considerations such as risks from fire, disease, and damage.

Esthetic Considerations

One important nontimber concern of managers is the visual resource. Much of the lodgepole pine type is at middle to high elevations in mountainous areas and frequently forms the forest background and setting for outdoor recreation activities such as hiking and camping. To determine the effect of harvest treatments on the visual resource, two evaluations of harvest treatments in lodgepole pine areas were made. Landscape architects rated the areas, and the Scenic Beauty Estimation (SBE) technique (Daniel and Boster 1976) was used to measure viewers' preferences for different scenes. This method consists of taking color slide photos of forest scenes and having viewer groups rate the slides on a like-dislike scale. Although this does not measure scenic beauty in an absolute sense, it provides an interval-like measurement that is useful for comparing different scenes.

In this study, 11 scenes were evaluated, including three 66 percent units, two 33 percent units, and other scenes that were not part of the sample harvest units but are common conditions in lodgepole areas--clearcuts, mechanical thinnings, commercial thinnings, and uncut areas. Four different viewer groups rated the areas, but there were only minor differences among groups, so the results given here are based on combined ratings.

Scenic Beauty Ratings--The viewer group ratings for the 11 scenes are shown in figure 2. The SBE technique expresses preferences relative to a base area. In this case, the forest-meadow edge scene, usually considered a pleasing pastoral scene, is the base and all other areas are compared on a "dislike" basis. The mechanical thinning area was disliked the most, relative to the meadow edge scene. The Echo Lake 66 percent basal area reduction unit was disliked relative to the meadow edge, but ranked higher than most other treatments evaluated. The position of the bars in figure 2 indicates the relative preference among areas. Most thinning units were intermediate in scenic beauty ratings.

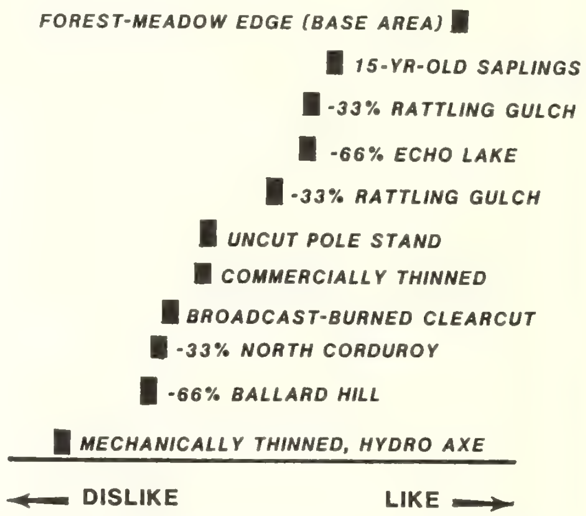

Figure 2--Scenic Beauty Estimation ratings by viewers of color slides of various treatments in lodgepole pine stands.

Because ratings differed, even among areas with similar treatments, regression analysis was used to try to explain differences in terms of physical-visual characteristics, such as number of trees, size of trees, and amount of slash. These characteristics were measured or estimated from the color slides and used as explanatory (independent) variables; the SBE score for each slide was used as the response (dependent) variable. Analyses were made for individual groups and combined groups using alternative regression models. Results were highly variable, but several characteristics appeared to be fairly consistent in their association with preference scores. Greater amounts of green groundcover vegetation under the stand were consistently associated with higher preference ratings, as were larger diameter leave-trees for some of the viewer groups. Down slash, bare and disturbed ground, and large numbers of small (<3 inches d.b.h.) trees appeared to detract from ratings.

Visual Quality Objective (VQO)--In addition to having viewer groups rate the areas, the same slides were shown to landscape architects who were asked to rate the slides as to the Forest Service visual quality objective (USDA Forest Service 1974) category they thought it represented (assuming they were passing by the areas in a car or on foot, and in a general timber growing zone). The VQO classification of the 11 areas

was as follows, with the ranking of SBE ratings in parentheses:

VQO class	Area and SBE ranking
Retention (management not evident)	Meadow-forest edge (1st) Uncut stand (7th)
Partial retention (management activities subordinate)	15-year saplings (2d) Two -66 percent units (3d, 4th) Both -33 percent units (5th, 9th) Commercially thinned area (6th)
Modification (management evident, but borrows from visual form)	One -66 percent (10th) Broadcast-burned area (8th) Mechanically thinned area (11th)

This indicates that, with proper slash treatment, thinned lodgepole stands can meet partial retention, a common objective in timber growing areas, but treatments, such as the mechanical thinning or burning, that leave slash and disturbance, should be avoided in viewer-sensitive areas.

Other Considerations

Several other studies of nontimber considerations were made as part of the posttreatment evaluation of harvest areas, and to some extent they indicated that tradeoffs are involved when evaluating thinning intensity and related harvesting concerns. For example, Lyon (this proceedings) found that uncut stands or light thinning preserved hiding cover for wildlife, but Hungerford (this proceedings) noted that more vigorous disturbance and opening up the stand may be needed to prevent loss of some browse species. In this case, two different aspects of a single resource, wildlife habitat, are involved, as illustrated in figure 3.

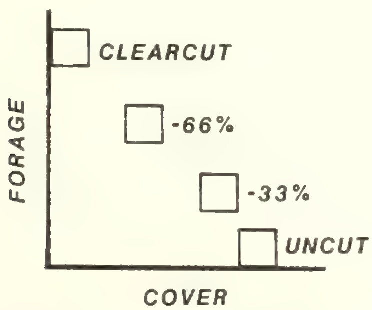

Figure 3--Tradeoff between wildlife forage and cover at different harvesting intensities.

Managers are also concerned about the risk to the investment made in the residual stand. Evaluations 2 years after treatments (Schmidt and Barger this proceedings) indicated that wind and snow losses in uncut (control) stands are virtually 0, but averaged about 1 percent in -33 percent units and more than 3 percent in -66 percent units. Additionally, losses to windthrow in the residual stand of treated units adjacent to clearcuts were as much as 47 percent. Here the tradeoff to be considered is between greater value growth response in -66 percent thinnings and the probability of greater losses through weather agents, as portrayed in figure 4.

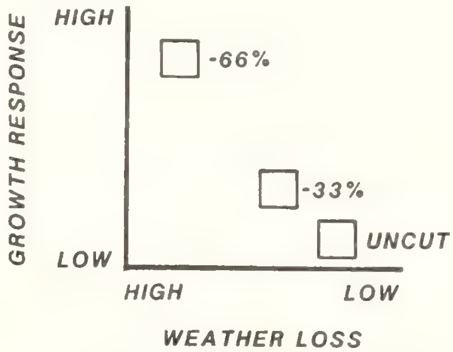

Figure 4--Tradeoff between timber volume growth response and weather loss at different harvesting intensities.

Brown and Johnston (this proceedings) indicate that the potential for suppression of wildfire in thinned stands is probably related more to level of slash removal than thinning intensity. Removal of larger (3-inch+) slash was estimated to reduce fireline intensity by half; in addition, Lyon (this proceedings) indicated that this level of slash removal would largely remove any barriers to big game movement. However, as noted earlier, the removal of nonmerchantable material represented a cost that made the difference between a net return versus a net loss for some units in the study. There appears to be, therefore, a multidimensional tradeoff involved that includes level of thinning, level of slash removal, and both near- and long-term effects on management risks and nontimber concerns.

CONCLUSIONS

The 25 pole-size, overstocked stands of lodgepole pine that were treated in the harvesting studies were selected because they were considered typical of the range of stands managers might consider for treatment with thinning to recover potential product values. Several units were also clearcut to provide a comparison with thinning treatments.

Results from treating these stands indicate there is a narrow, critical range of conditions that determine whether or not treatment is economically feasible. Lodgepole pine stands are usually considered a rather uniform, simple forest system, with a single tree species and only a few habitat types representing vast areas. However, the range of diameters and stocking represented in the study area stands resulted in certain cases where product recovery was high enough, and thinning

and slash treatment costs low enough, to create a profitable or at least break-even situation. Other areas that were physically similar, but with somewhat lower product values, have treatment costs higher than present product values, and even with some growth response projected for the residual stand do not appear to be an economically viable harvesting chance.

Some nontimber resources will benefit from thinning treatments, especially after some years of vegetative regrowth, but there are also tradeoff costs, such as an unavoidable period when weather or risk of fire threatens the "investment" (the residual stand).

It appears, therefore, that investment in thinning lodgepole pine stands like those represented in this study may require very close scrutiny to determine whether short-term and long-term timber values and changes in nontimber resource values come together to make intermediate thinning a wise or unwise management option. Unlike some management situations where large timber and high nontimber values guarantee a "black ink" operation, these lodgepole stands probably have to be considered on a stand-by-stand basis. Stocking, site potential, products, and even operator efficiency should all be part of the decision process. The economic costs and values, and the nontimber concerns discussed in this paper, should be viewed as possible choices and outcomes; each individual stand, however, will have its own outcome.

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Includes 22 reports of research sponsored by the Systems of Timber Utilization for Environmental Management Program relating to evaluating management alternatives for small-stem natural stands of lodgepole pine.

KEYWORDS: *Pinus contorta*, stand characteristics, management issues, silviculture, harvesting economics, harvesting systems, products, utilization, response to management, nontimber resource effects

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Concepts and Interpreted Examples In Advanced Fuel Modeling

Robert E. Burgan

THE AUTHOR

ROBERT E. BURGAN received his undergraduate degree in forest engineering in 1963 and his master's degree in forest fire control in 1966 from the University of Montana. From 1963 to 1969, he served on the timber management staff of the Union and Bear-Sleds Districts, Wallowa-Whitman National Forest. From 1969 to 1975, he was a research forester on the staff of the Institute of Pacific Islands Forestry, Honolulu, HI. He transferred to the National Fire-Danger Rating research work unit at the Northern Forest Fire Laboratory (now the Intermountain Fire Sciences Laboratory), Missoula, MT, in 1975. From 1979 to 1987 he was a research forester in the Fire Behavior: Fundamentals and Systems Development research work unit at the lab. He is currently a research forester with the Forest Meteorology and Eastern Fire Management research work unit at the Southern Forest Fire Laboratory in Macon, GA.

RESEARCH SUMMARY

The basic concepts of fuel modeling were presented in the fuel subsystem of BEHAVE. This report expands on these concepts in an attempt to provide a better understanding of the technical details of constructing site-specific fire behavior fuel models.

The discussion is mathematical. It is aimed at fire managers who are familiar with the fire model and who may be dealing with difficult fuels situations.

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Robert E. Burgan

INTRODUCTION

The basic concepts of fuel modeling were presented in the manual for the fuel subsystem of BEHAVE (Burgan and Rothermel 1984). This paper expands on these concepts in an attempt to provide a better understanding of technical details of fuel modeling. The reader should be familiar with the basic concepts before studying the more detailed discussion presented here.

This discussion is necessarily mathematical. It is aimed at fire managers who wish to become more proficient in fuel modeling and who may be dealing with difficult fuels situations. Basic concepts will be reviewed to provide a foundation for discussing examples of fuel models. These examples will be used to illustrate how changes in various fuel model parameters affect predicted fire behavior and to provide insight into the technical details of fuel modeling.

The equation developed to calculate the rate of spread in wildland vegetation (Rothermel 1972) is:

$$R = \frac{I_R \xi \, (1 + \phi_w + \phi_s)}{\rho_b \varepsilon \, Q_{ig}}$$

where:

R = rate of spread, ft/min
I_R = reaction intensity, Btu/ft^2/min
ξ = propagating flux ratio, dimensionless
ϕ_w = wind coefficient, dimensionless
ϕ_s = slope coefficient, dimensionless
ρ_b = ovendry bulk density, lb/ft^3
ε = effective heating number, dimensionless
Q_{ig} = heat of preignition, Btu/lb.

We will rely primarily on ϕ_w, ξ, I_R, and a fourth term, Γ', in this discussion because the size of individual particles (σ) and density of the fuel bed (ρ_b) exercise their strongest effect through these parameters. Briefly, Γ' is defined as the optimum reaction velocity and is used in calculating I_R. Each of these four terms will be further defined, its equation presented, and its characteristics discussed.

WIND COEFFICIENT (ϕ_w)

The wind coefficient is a dimensionless multiplier that accounts for the increased spread rate resulting from improved radiant and convective heat transfer and oxygen flow in wind-driven fires.

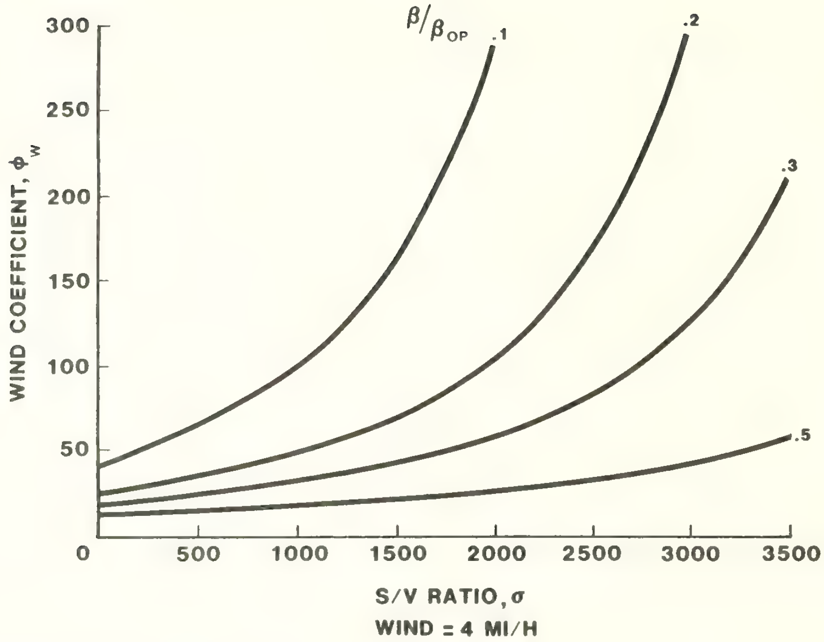


Figure 1—The wind coefficient increases as the surface-area-to-volume ratio of the fuels increases, and the effect becomes greater as the fuel bed density decreases.

The equation for ϕ_w is:

$$\phi_w = CU^B (\beta/\beta_{op})^{-E}$$

where:

C, B and E are functions of fuel particle size only and thus are constant for any given "characteristic" surface-area-to-volume ratio (σ). Unless otherwise noted, σ will mean the "characteristic" or weighted average surface-area-to-volume ratio that represents all the fuels in the fuel model.

U is the windspeed in feet per minute (mi/h * 88).

β/β_{op} is the ratio of the actual packing ratio (β) to the optimum packing ratio (β_{op}). β_{op} is constant for any given σ.

Thus ϕ_w is a function of the characteristic σ, the packing ratio (β), and the windspeed (U). C, B and E are σ-dependent correlation parameters used to fit the equation to the original data. The upward slope of ϕ_w (fig. 1) is produced by the fact that windspeed (U) is raised to an increasingly larger power (B) as σ increases. C decreases as σ increases, but not enough to counteract the effect of U^B. Figure 1 also shows the wind coefficient increases faster for lightly loaded fuel beds; that is, those whose β/β_{op} ratio is low.

Figure 2 shows that ϕ_w decreases rapidly as β/β_{op} increases, but as fuel beds become more and more tightly packed, the rate of decrease in ϕ_w slows.

In summary, remember that for a given windspeed:

1. ϕ_w increases as the windspeed increases.
2. ϕ_w increases as σ increases. (The effects of wind are more pronounced in fine fuels.)
3. ϕ_w increases as β/β_{op} decreases; that is, as the fuel bed becomes more airy or fluffy.
4. The slope coefficient (ϕ_s) (which will not be discussed in detail), also decreases as the packing ratio increases, but the effect of slope is much less than the effect of wind.

In general, a fuel model can be made more sensitive to wind by increasing σ, by increasing fuel bed depth, or by decreasing fuel load.

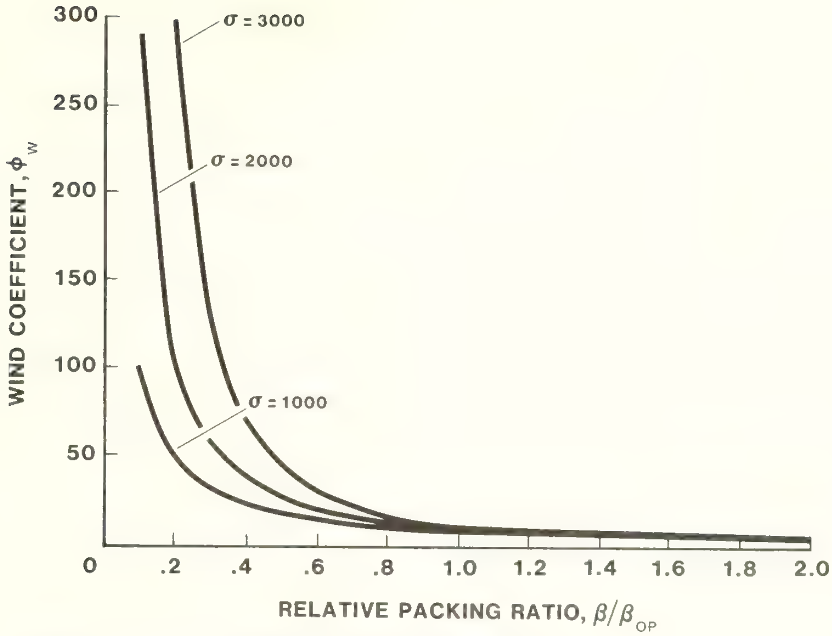


Figure 2—The wind coefficient decreases rapidly as the fuel bed density increases.

REACTION VELOCITY (Γ)

Reaction velocity is defined as the ratio of the efficiency of the fire to the reaction time. It is a measure of the actual rate of fuel consumption; that is, a measure of the speed of the combustion reaction. The units are per minute.

Discounting the effects of moisture and minerals upon burning rate, the potential reaction velocity, Γ' is given by:

$$\Gamma' = \Gamma'_{max} (\beta/\beta_{op})^A \exp [A (1 - \beta/\beta_{op})]$$

where:

Γ'_{max} is the rate of fuel consumption when the fuel bed packing ratio is optimum ($\beta = \beta_{op}$), dimensionless.

β/β_{op} is the ratio of actual to optimum packing, dimensionless.

A is an arbitrary variable dependent on σ.

Throughout the discussion, the potential reaction velocity will be referred to as the reaction velocity and be represented by the symbol Γ'.

Figure 3 shows that Γ' increases as β/β_{op} increases from 0 to 1, at which point Γ' is at a maximum, and then decreases again as the fuel bed is more tightly packed. At optimum packing, $\Gamma' = \Gamma'_{max}$ by definition. The influence of σ on the exponent, A, produces a family of reaction velocity curves for various σ's, with the interpretation being that fires burn faster in finer fuels.

In summary, remember that:

1. Γ' increases rapidly to a maximum value at β_{op}, then tapers off as the packing ratio increases.
2. Γ' peaks at higher values as σ increases.

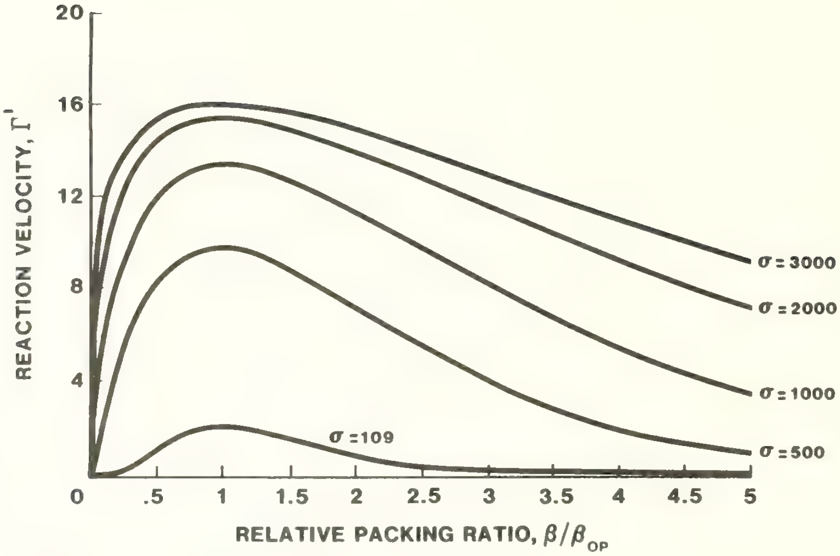


Figure 3—The reaction velocity is at a maximum when the fuel bed density is optimized to provide the best fuel/air ratio. This occurs when the relative packing ratio is 1.

PROPAGATING FLUX RATIO (ξ)

The propagating flux ratio is a dimensionless number indicating the proportion of the total heat produced in the combustion zone that actually preheats adjacent fuel particles to ignition.

The equation for ξ is:

$$\xi = (192 + 0.2595\sigma)^{-1} \exp\left[(0.792 + 0.681\sigma^{0.5})(\beta + 0.1)\right]$$

where:

σ is the surface area to volume ratio, ft^2/ft^3

β is the packing ratio, dimensionless.

ξ can theoretically vary from nearly 0 to 1 (fig. 4). It tends toward 0 as either β or σ decreases; that is, as the fuel bed gets more fluffy or the fuel particle size increases.

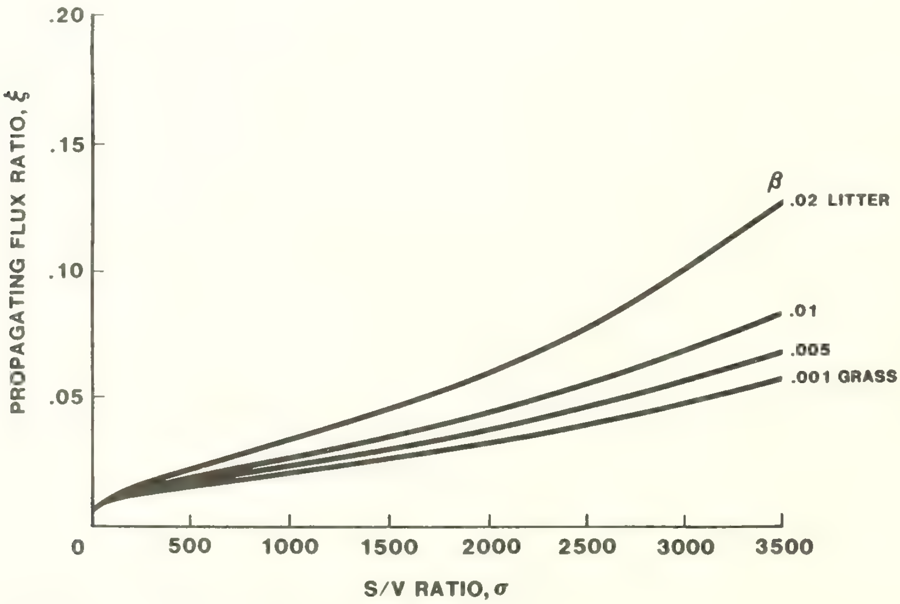


Figure 4—The proportion of heat produced in the combustion zone that actually contributes to fire propagation ranges from 0 to 20 percent, depending on fuel particle size and fuel bed compactness.

Figure 4 shows how ξ increases as σ increases for various packing ratios. Notice that ξ increases more rapidly as σ increases in tightly packed fuel beds such as litter than in loose fuel beds such as grass. Figure 5 illustrates that, as β increases, ξ increases exponentially to a theoretical maximum value of 1. In reality, values above about 0.2 are not likely in surface fires.

In summary, remember that ξ increases when **either** β or σ increases.

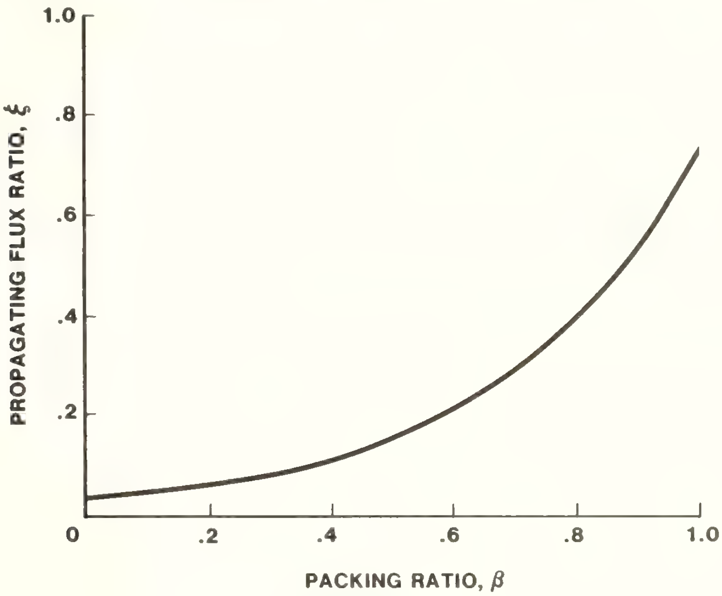


Figure 5—The proportion of heat that contributes to fire propagation increases as the fuel bed becomes more tightly packed. Values above 20 percent are not likely in surface fires.

REACTION INTENSITY (I_r)

Reaction intensity is a measure of the energy release rate per unit area of combustion zone. The units are Btu/ft^2/min. There is no implication of where this energy is going; it is just a **total** energy production rate per unit area in the flaming zone.

The equation for I_r is:

$$I_r = \Gamma' w_n h \eta_m \eta_s$$

where

$$w_n = w_o (1 - S_t)$$

and

S_t = mineral content fraction of total fuel load (0.0555), a value determined by analysis to be common for many wildland fuels and assumed constant in this paper

but

$$w_o = \rho_b \delta$$

so

$$w_n = \rho_b \delta (1 - S_t)$$

but since $(1 - S_t) = 0.9445$ it can be approximated to 1 to simplify this discussion.

Then

$$w_n \cong \rho_b \delta$$

and

$$I_r \cong \Gamma' \rho_b \delta h \eta_m \eta_s$$

where:

Γ' = reaction velocity (1/min)

ρ_b = the ovendry bulk density (lb/ft^2)

δ = fuel bed depth (ft)

h = heat content (Btu/lb)

η_m = moisture damping coefficient, dimensionless

η_s = mineral damping coefficient, dimensionless.

The heat content, h, is very straightforward in its effects on fire behavior—fire potential increases as heat content increases and vice versa. That is, fire behavior outputs respond directly and linearly with changes in heat content. For forest fuels, a common heat content is 8,000 Btu/lb.

For the moment, consider the moisture and mineral damping coefficients to be constant. Thus, if h, η_m, and η_s can be ignored momentarily, we need concern ourselves with only three parameters in the reaction intensity equation: Γ', ρ_b, and δ. Remember Γ' is a function of the relative packing ratio (β/β_{op}) and σ, while ρ_b is a function of load and depth. Γ' will always peak when the packing ratio is optimum, but I_r may peak at a higher than optimum packing ratio. This occurs because the addition of more fuel per unit volume (ρ_b and β increasing) will continue, for a while, to increase the total energy release rate even though the combustion rate for individual fuel particles is slowing, because there are simply more fuel particles burning. Eventually, however, the fuel bed becomes so compact and the reaction velocity (Γ') is slowed sufficiently so that the total rate of heat output, I_r, begins to decrease.

In summary, remember that I_r:

1. Is a function of reaction velocity (Γ'), which depends on packing ratio (β) and fuel particle size (σ).
2. Will eventually decrease with increased packing ratio due to the drop in reaction velocity (Γ').
3. Does not necessarily peak at the optimum packing ratio as does Γ'.
4. Is affected by the heat content.
5. Is affected by fuel moisture.

INTERPRETING FUEL MODEL EFFECTS ON STANDARD FIRE BEHAVIOR OUTPUTS

We now apply the above concepts to ascertain how changes in fuel model parameters might affect:

1. Rate of spread.
2. Byram's fireline intensity.
3. Flame length.

Rate of Spread

Remember the rate of spread equation is:

$$R = \frac{I_r \, \xi \, (1 + \phi_w + \phi_s)}{\rho_b \, \varepsilon \, Q_{ig}}$$

But in the reaction intensity discussion we left

$$I_r \cong \Gamma' \rho_b \, \delta h \, \eta_m \, \eta_s$$

so

$$R \cong \frac{\Gamma' \rho_b \, \delta \xi h \, \eta_m \, \eta_s \, (1 + \phi_w + \phi_s)}{\rho_b \varepsilon \, Q_{ig}}$$

Knowing that heat content (h), moisture damping (η_m), and mineral damping (η_s) are important, we will recognize their presence by assigning the product of these three parameters a constant value V for this discussion. That is, $V = h \, \eta_m \eta_s$ and cancelling ρ_b.

$$R \cong \frac{\Gamma' \, \delta \xi V (1 + \phi_w + \phi_s)}{\varepsilon \, Q_{ig}} \qquad \text{(Eq. X)}$$

where the two unfamiliar parameters are:

ε = an effective heating number

Q_{ig} = the heat of preignition.

Unless fuel moistures are changed, Q_{ig} is constant, so we may disregard it for the moment. ε is an estimator of the proportion of a fuel particle that must be heated to ignition in the flaming front. It increases as σ increases, that is, a larger fraction of finer fuels must be heated.

To see how the rate of spread in equation X is going to be affected by changes in a fuel model parameter, we only need to evaluate how that change will affect the size of the numerator with respect to the size of the denominator. Let us look at how our three most important fuel model parameters—load, S/V ratio, and depth—affect the numerator and denominator of the above-simplified rate of spread equation.

Load—Increasing load (holding depth constant) increases the packing ratio. This will:

1. Increase the reaction velocity (Γ') until the packing ratio is optimum, then as load is increased further, Γ' will begin to decrease (fig. 3). Thus, increasing load can either increase or decrease the numerator.
2. Increase the propagating flux ratio (ξ) (fig. 4), and therefore increase the numerator of the spread equation.
3. Decrease the wind coefficient ϕ_w very rapidly at first, then more slowly as the fuel bed becomes more tightly packed (fig. 2), and therefore decrease the numerator.
4. Decrease the slope coefficient in a manner similar to the wind coefficient. Compared to the effect of wind, the effect of slope is small and therefore it is not discussed in detail.

S/V Ratio—Increasing the S/V ratio, σ, will:

1. Increase the reaction velocity, and thus the numerator in loosely packed fuels. The point of maximum reaction velocity will be shifted to lower packing ratios (fig. 3). Remember that fine fuels burn best when loosely packed, while coarse fuels burn best when packed more tightly.
2. Increase the propagating flux ratio (fig. 4) and thus the numerator.
3. Increase the wind coefficient considerably for fuel beds with a low packing ratio, but not much for tightly packed fuel beds (fig. 1). The numerator would increase.
4. Increase the effective heating number, which would increase the denominator, thus producing an opposing effect to the first three. This will be minor, however, and the general trend is that for increasing σ, spread rate will increase in loosely packed fuel and decrease in tightly packed fuel.

Depth—Increasing depth (holding load constant) decreases the packing ratio. This will:

1. Increase the reaction velocity when the packing ratio is greater than optimum, decrease it when reaction velocity is less than optimum (fig. 3). Thus a change in depth may either increase or decrease this term of the numerator.
2. Decrease the propagating flux ratio (fig. 4), and the numerator.
3. Increase the wind coefficient (fig. 2) and thus the numerator.

A good rule of thumb is that increasing depth usually increases rate of spread due to the more porous fuel bed.

Byram's Fireline Intensity

Byram's fireline intensity is a measure of the rate of heat production per lineal foot of flaming front per second (Btu/ft·s).

The equation for fireline intensity (I_B) is:

$$I_B = 384\ I_r\ R/(60 * \sigma)$$

Thus, all the previously discussed interactions that affect reaction intensity (I_r) and rate of spread (R) also affect the fireline intensity.

Flame Length

Flame length is purely a function of Byram's fireline intensity:

$$FL = 0.45\ I_B^{0.46}$$

Flame length is responsive to changes in the fuel model parameters in approximate proportion to the square root of Byram's fireline intensity.

EXTINCTION MOISTURE

Extinction moisture is a fuel model parameter that can have a moderate to a strong influence on predicted fire behavior, depending on a number of factors. Basically, it is defined as the dead fuel moisture content at which a fire will no longer spread with a uniform flame front and the model predicts zero spread rate. Predicted fire intensity and spread rate will increase when the difference between the actual fuel moisture and the dead fuel extinction moisture increases. This occurs as dead fuels become drier. Increasing

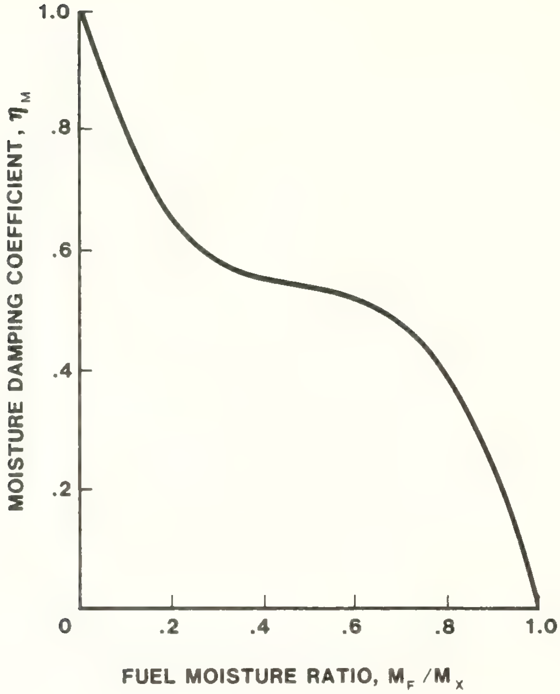


Figure 6—Fire behavior is most responsive to changes in dead fuel moisture when the fuels are either relatively dry or relatively wet.

the dead fuel moisture will have an opposite effect. Fire behavior predictions are much more responsive to changes in the difference between actual and extinction moistures when the actual moisture is close to the extinction moisture. That is, the response of a fuel model to changes in moisture is not linear (fig. 6).

INTERPRETATION OF EXAMPLE FUEL MODELS

With the above guides, we will interpret some graphs produced by the technical version of TSTMDL. The first model will have 1 ton/acre of fuel in the 1-h class and no load in any other class. Subsequent examples will be generated by adding 1 ton/acre in each of the remaining classes. There are a total of six examples as summarized in the following tabulation:

Example No.	Load (tons/acre)					Model type	
	1-h	10-h	100-h	Herb	Woody	Static	Dynamic
1	1					x	
2	1	1				x	
3	1	1	1			x	
4	1	1	1	1		x	
5	1			1		x	
6	1			1			x

In all cases, the 1-h S/V ratio will be 2,000 ft^2/ft^3; when applicable, the herb and woody S/V ratio will also be 2,000, the depth will be 0.5 ft, and the heat content will be 8,000 Btu/lb.

We will also use standard environmental data, either low or high moisture as tabulated below.

	Environmental conditions	
	Low moisture	High moisture
	Percent	
1-h	3	12
10-h	4	13
100-h	5	14
Live herb	70	170
Live woody	70	170
Windspeed, mi/h	4	4
Slope, percent	30	30

Example 1

Data for the first example are shown in the following tabulation:

Fuel Model Test Run—User-Defined Environmental Inputs

Static 14. Load 1 By: Burgan

Load (T/AC)		S/V Ratios		Other	
1 HR	1.00	1 HR	2000.	Depth (feet)	0.50
10 HR	0.00	Live herb	0.	Heat content (Btu/lb)	8000.
100 HR	0.00	Live woody	0.	Ext moisture (%)	25.
Live herb	0.00	Sigma	2000.	Packing ratio	0.00287
Live woody	0.00	S/V = (sqft/cuft)		PR/OPR	0.43

Environmental Data		Fire Behavior Results: Fire Variable	Midflame Wind 0.	4.	8.
1 HR FM	3.				
10 HR FM	4.				
100 HR FM	5.	ROS (ft/m)	8.	38.	93.
Live herb FM	70.	FL (ft)	2.	5.	8.
Live woody FM	70.	IR (Btu/sq ft/m)	1546.	1546.	1546.
		H/A (Btu/sq ft)	297.	297.	297.
Slope (%)	30.	FLI (Btu/ft/sec)	41.	187.	462.

The optimum packing ratio for this model is 0.00667 and the optimum loading is 2.32 tons/acre.

Load Effects—The spread rate peaks at about 0.75 ton/acre, the flame length at about 7 tons/acre, and the reaction intensity at about 10 tons/acre (fig. 7). Why does each of these fire behavior outputs peak at a different load?

First consider what is happening to the reaction intensity (fig. 7). Remember that I_r is a product of reaction velocity and fuel load, assuming heat content, and moisture and mineral damping coefficient are constant. The reaction velocity **always** peaks at the optimum packing ratio, which occurs at a load of 2.32 tons/acre in this case. So, because the reaction velocity is decreasing at loadings greater than 2.32 tons/acre, the reaction intensity can continue to increase beyond that point only because the reaction velocity is being multiplied by an increasing load. Finally, however, beyond about 10 tons/acre, the reaction velocity is decreasing so much that it begins to dominate, so the reaction intensity begins to decrease as the fuel load increases beyond 10 tons/acre.

Spread rate (fig. 7) increases to a maximum at about 0.75 ton/acre, then slowly tapers off. The abrupt end to the rapid increase in spread rate is particularly interesting. At 0.75 ton/acre the reaction velocity and reaction intensity are still increasing because the optimum packing ratio, which occurs at 2.32 tons/acre, has not yet been reached. The propagating flux ratio always increases as load increases, so none of these can account for the cap on spread rate. But the windspeed is 4 mi/h, and the wind coefficient is decreasing rapidly as the packing ratio increases (fig. 2). The slope coefficient is acting similarly. Lightly loaded models like this one are very sensitive to the ϕ_w and ϕ_s multipliers; thus, they exert a strong influence on the spread rate numerator, which represents a heat source. In addition, the heat sink, represented by the denominator, is increasing because of the addition of more fuel. At 0.75 ton/acre these effects in the numerator and denominator suddenly stop the increase in spread rate. The long, gradual decrease in spread rate results from decreasing reaction velocity, wind, and slope coefficients, and an increasing heat sink. These combined effects just barely offset the increase in reaction intensity up to about a 10 tons/acre load. Beyond that, even the reaction intensity decreases.

Flame length (fig. 7) is a function of both spread rate and reaction intensity, and so peaks when the product of the decreasing spread rate and the increasing reaction intensity is a maximum.

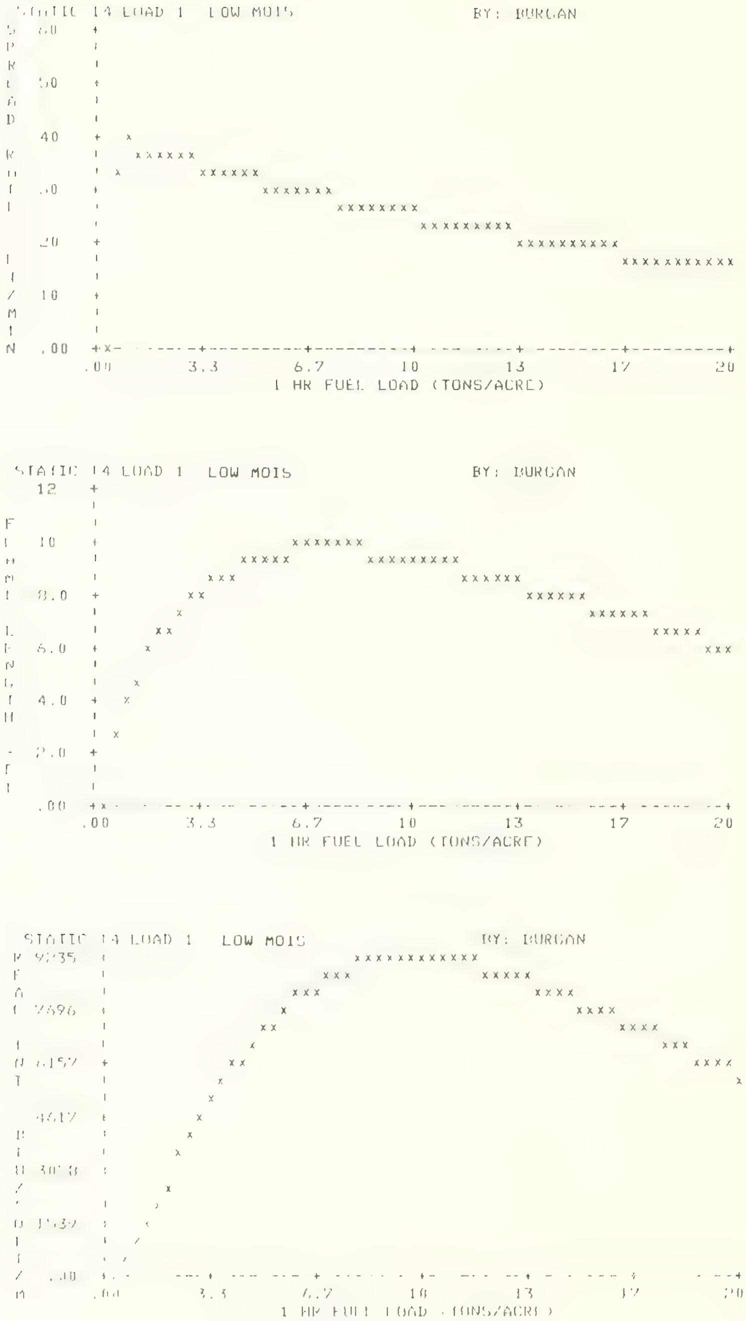


Figure 7—One-hour fuel load, example 1.

S/V Effects—Spread rate increases when the S/V ratio increases (fig. 8) because Γ', ϕ_w, and ϕ_s and ξ all increase with increasing S/V ratios. Refer to figure 3 to note the effect on Γ', figure 1 to see the effect on ϕ_w, and figure 4 to see the effect on the propagating flux ratio. Thus, every parameter in the numerator of the previously defined approximation of the rate of spread equation:

$$R \cong \frac{\Gamma' \delta \xi V(1 + \phi_w + \phi_s)}{\varepsilon Q_{ig}}$$

is increasing. The denominator is also increasing because a larger proportion of the fuel particles are heated to ignition temperature as the fuel particle size decreases and the ef-

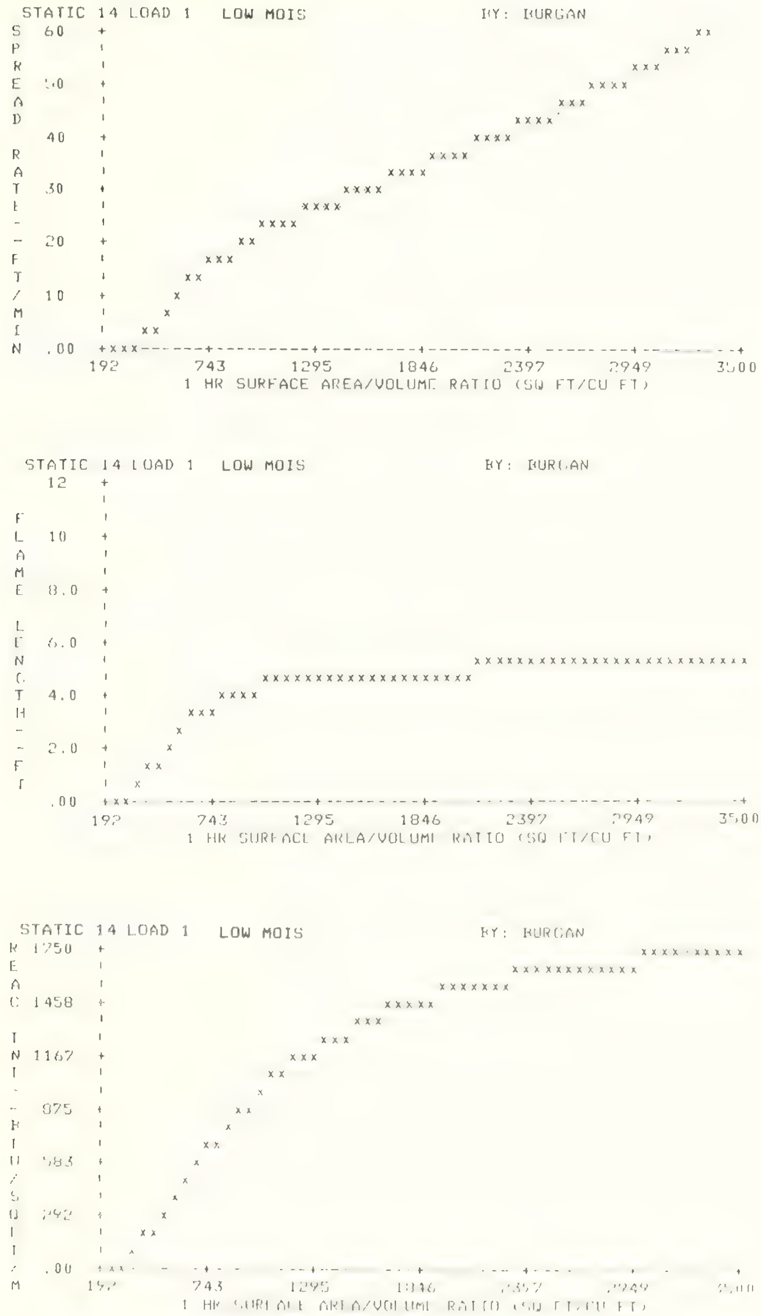


Figure 8—One-hour surface area/volume ratio, example 1.

fective heating number, ε, increases. Thus, the heat sink is becoming larger. But the numerator of the spread rate equation dominates in this case, so the spread rate increases.

Flame length increases (fig. 8) for a while and then flattens out because σ is in both the numerator and denominator of Byram's fireline intensity equation. Thus, even though spread rate is increasing, flame length increases as long as I_r increases rapidly, but stops increasing when I_r begins to flatten out.

Reaction intensity (fig. 8) is linearly related to reaction velocity, and, because in this case the packing ratio is less than optimum, the reaction velocity increases as the S/V ratio increases. So reaction intensity must also increase.

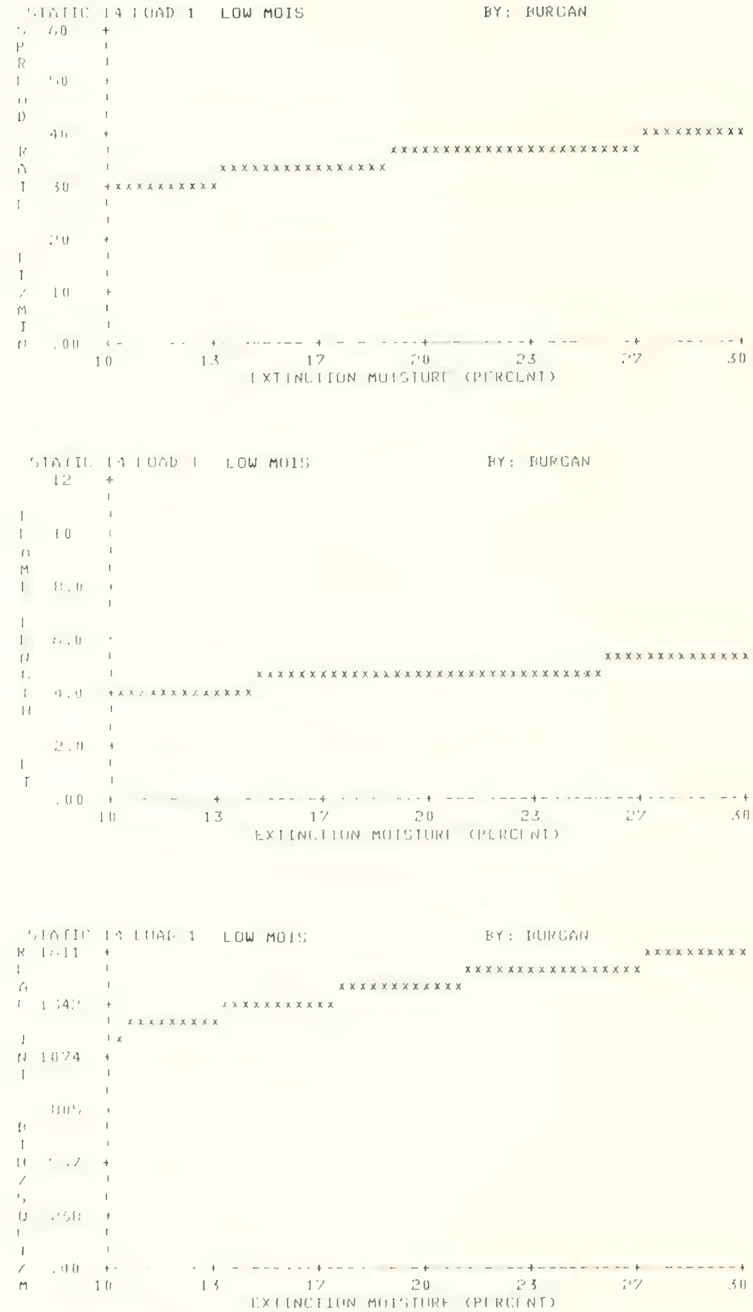
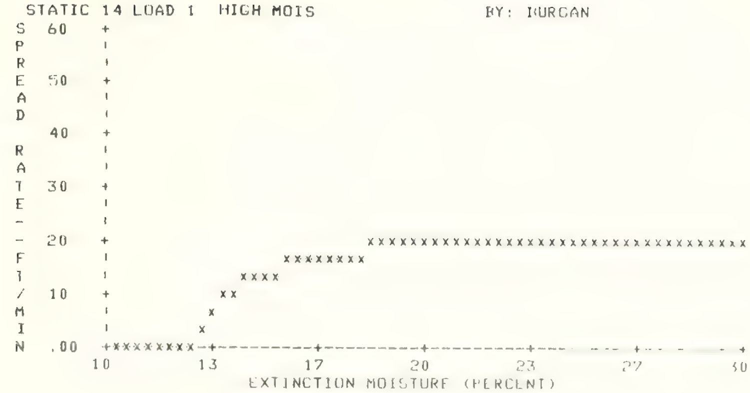
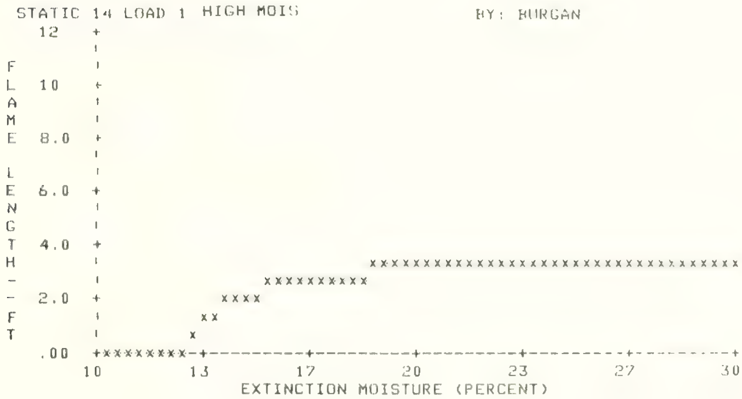


Figure 9—Extinction moisture, example 1, low fuel moisture.

Extinction Moisture Effects—Spread rate, flame length, and reaction intensity all increase as the extinction moisture increases, but notice that the effect is less pronounced at low fuel moisture (fig. 9) than at high fuel moisture (fig. 10).





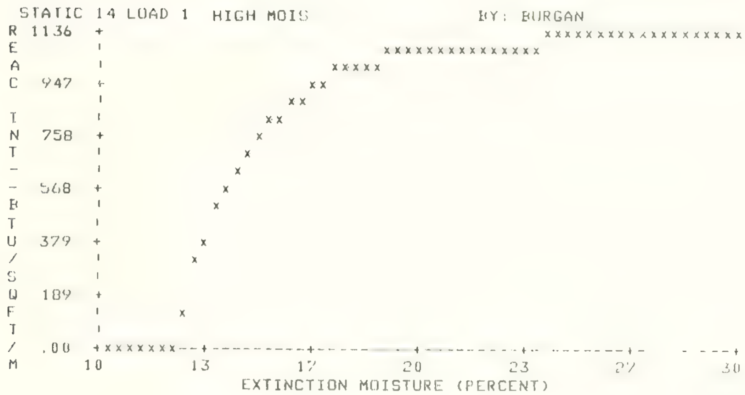


Figure 10—Extinction moisture, example 1, high fuel moisture.

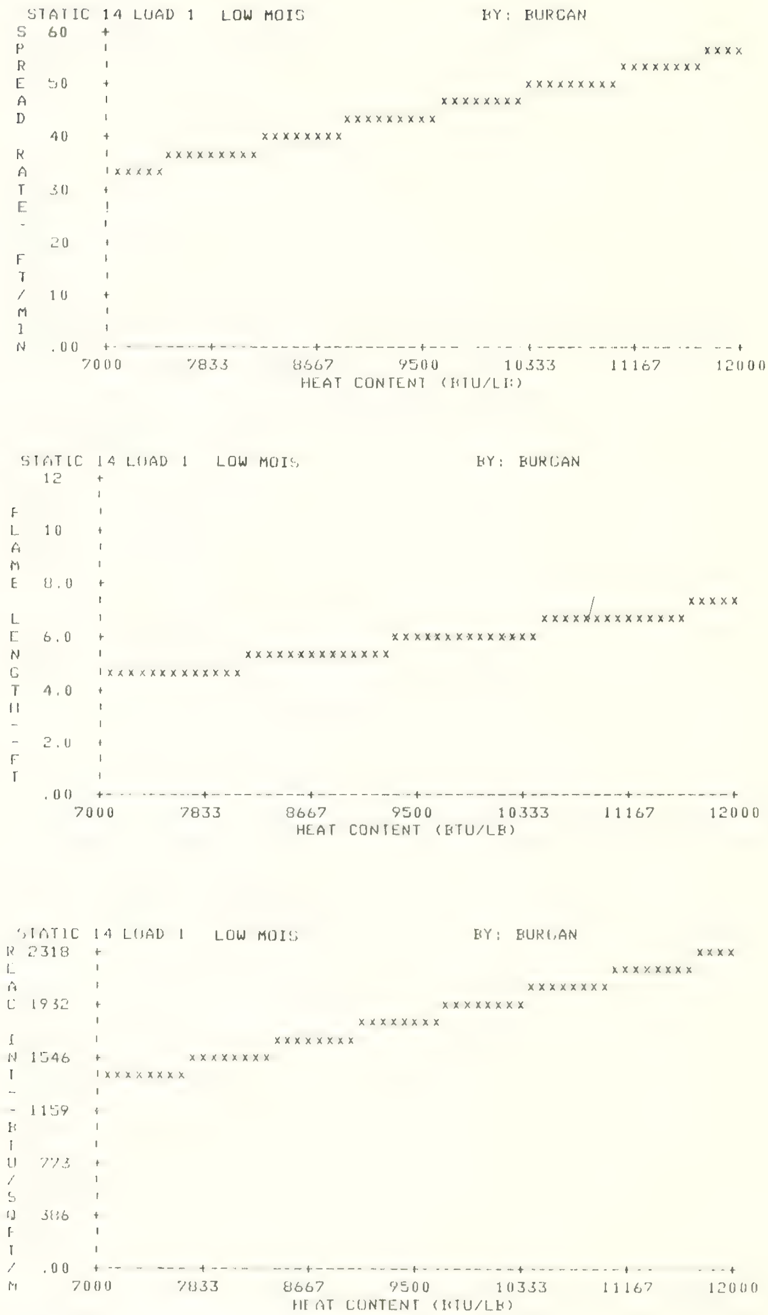


Figure 11—Heat content, example 1.

Heat Content Effects—Because heat content is a mulitiplier in the numerator of the spread equation, predicted fire behavior always increases when the heat content is increased (fig. 11).

Example 2

For the second example, 1 ton of fuel will be added to the 10-hour load.

Fuel Model Test Run—User-Defined Environmental Inputs

Static 15. Load 1,10 By: Burgan

Load (T/AC)		S/V Ratios		Other	
1 HR	1.00	1 HR	2000.	Depth (feet)	0.50
10 HR	1.00	Live herb	0.	Heat content (Btu/lb)	8000.
100 HR	0.00	Live woody	0.	Ext moisture (%)	25.
Live herb	0.00	Sigma	1902.	Packing ratio	0.00574
Live woody	0.00	S/V = (sqft/cuft)		PR/OPR	0.83

Enfironmental Data		Fire Behavior Results: Fire Variable	Midflame Wind 0.	4.	8.
1 HR FM	3.				
10 HR FM	4.				
100 HR FM	5.	ROS (ft/m)	4.	18.	43.
Live herb FM	70.	FL (ft)	2.	4.	6.
Live woody FM	70.	IR (Btu/sq ft/m)	1660.	1660.	1660.
		H/A (Btu/sq ft)	335.	335.	335.
Slope (%)	30.	FLI (Btu/ft/sec)	23.	100.	238.

In this case, the optimum packing ratio is 0.00691 and the optimum loading is 2.41 tons/acre.

Load Effects (1-h Varies)—When 1-h fuel load is varied in this model, a comparison of figure 12 with figure 7 shows the additional 10-h fuel slows the spread rate, as compared with example 1 because:

1. The characteristic S/V ratio (σ) is smaller (1,902 vs. 2,000), thus reducing the reaction velocity (fig. 3) and consequently the reaction intensity.
2. ϕ_w (and ϕ_s) are also reduced because σ is smaller (fig. 1).
3. The heat sink is increased because of the larger fuel load.

Notice also that the spread rate peaks at a much higher loading in example 2 (about 6 tons/acre) than in example 1 (about 1 ton/acre). The key to this change is that we are now mixing two fuel sizes (1-h and 10-h) **and** that the 1-h load is increasing from 0 to 20 tons/acre as the 10-h load remains constant.

Example 1 shows what happens when the fuel model is pure 1-h load; let us see what happens when the fuel model is pure 10-h load (fig. 13). Now the spread rate peaks at about 25 tons/acre. This is the situation in example 2 when the 1-h load is zero. Then, as 1-h load is added, the peak in figure 13 would shift to the left until the peak spread rate is produced at about 6 tons/acre for the combined 1-h and 10-h loads (fig. 12). Both packing ratio and the characteristic S/V ratio increase as the 1-h load is increased.

Flame length is lower in example 2 than example 1 because the reaction intensity and spread rate are both lower in example 2. The flame length peak shifts to the right (heavier loadings) because the spread rate, which is used to calculate flame length, peaks at a high load. The flame length peak is more rounded because the spread rate peak flattens.

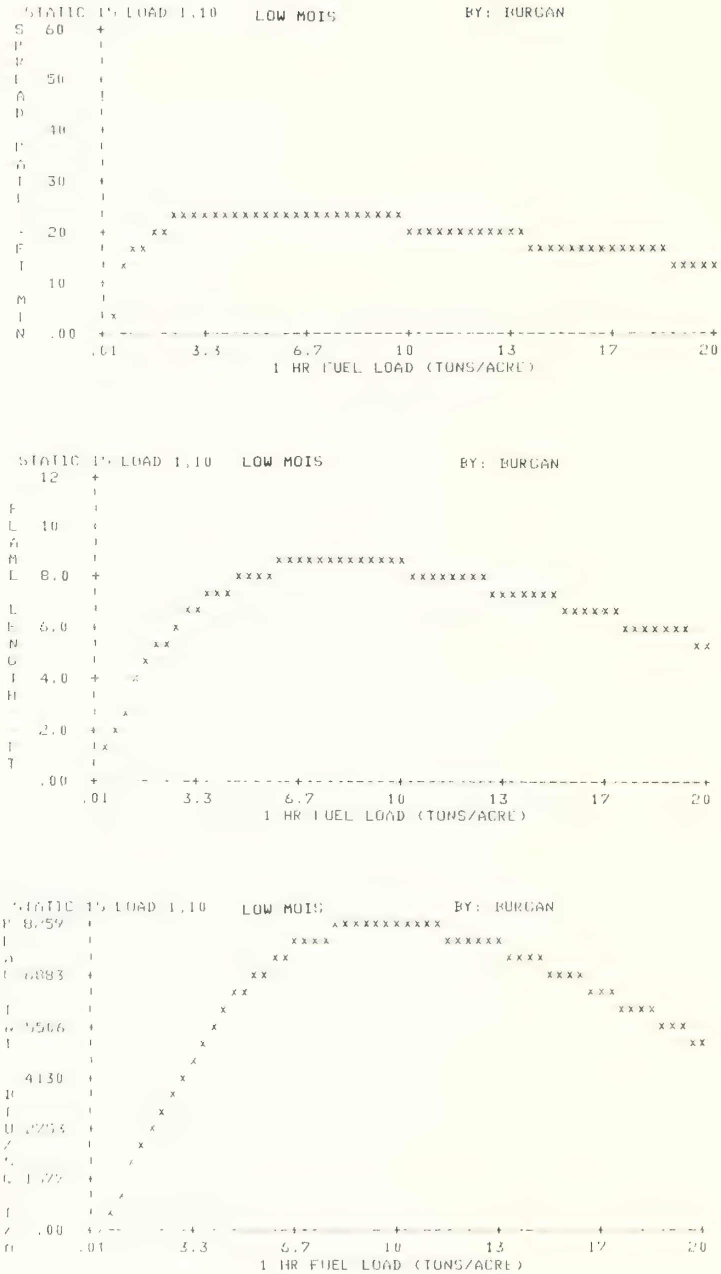


Figure 12—One-hour load, example 2.

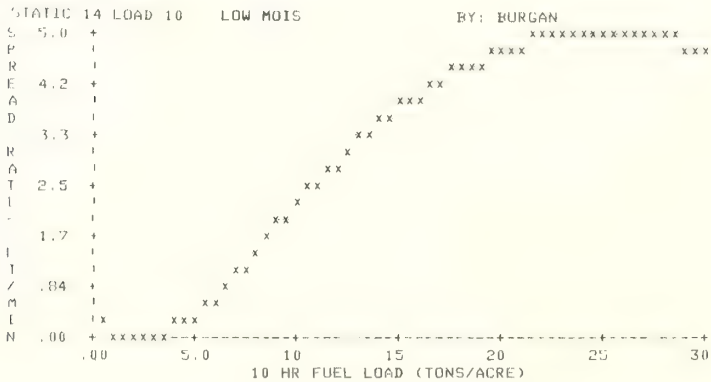


Figure 13—Ten-hour load only, example 2.

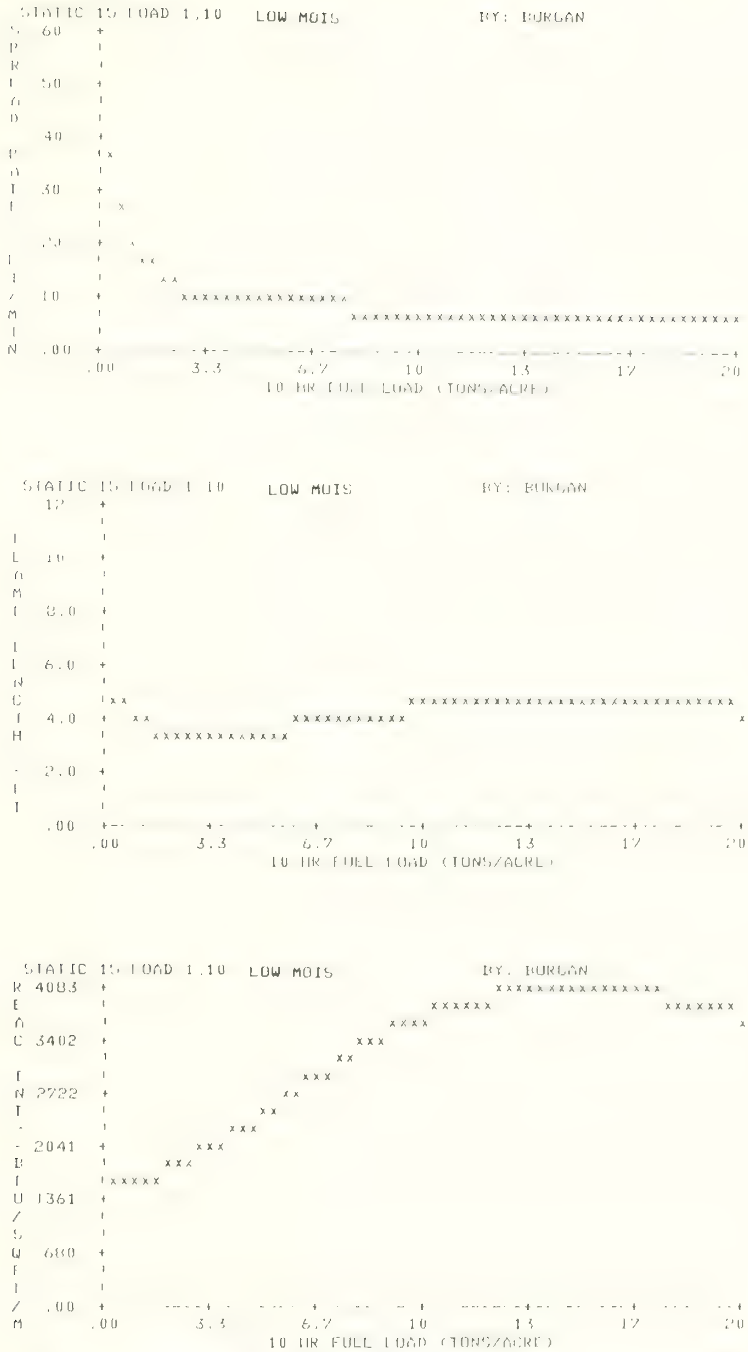


Figure 14—Ten-hour load with 1-hour load, example 2.

Load Effects (10-h Varies)—The addition of 10-h load decreases the characteristic S/V ratio, thereby reducing the wind coefficient (fig. 1). The heat sink (denominator of the spread equation) increases as 10-h fuel is added. Although the reaction intensity increases as 10-h fuel is added, it increases too slowly at first to offset the above effects so the spread rate drops rapidly at first, then more slowly as the reaction intensity begins to increase faster (fig. 14).

Flame length is a function of both spread rate and reaction intensity so it decreases while the rapidly decreasing spread rate dominates, then increases again as the reaction intensity begins to dominate (fig. 14).

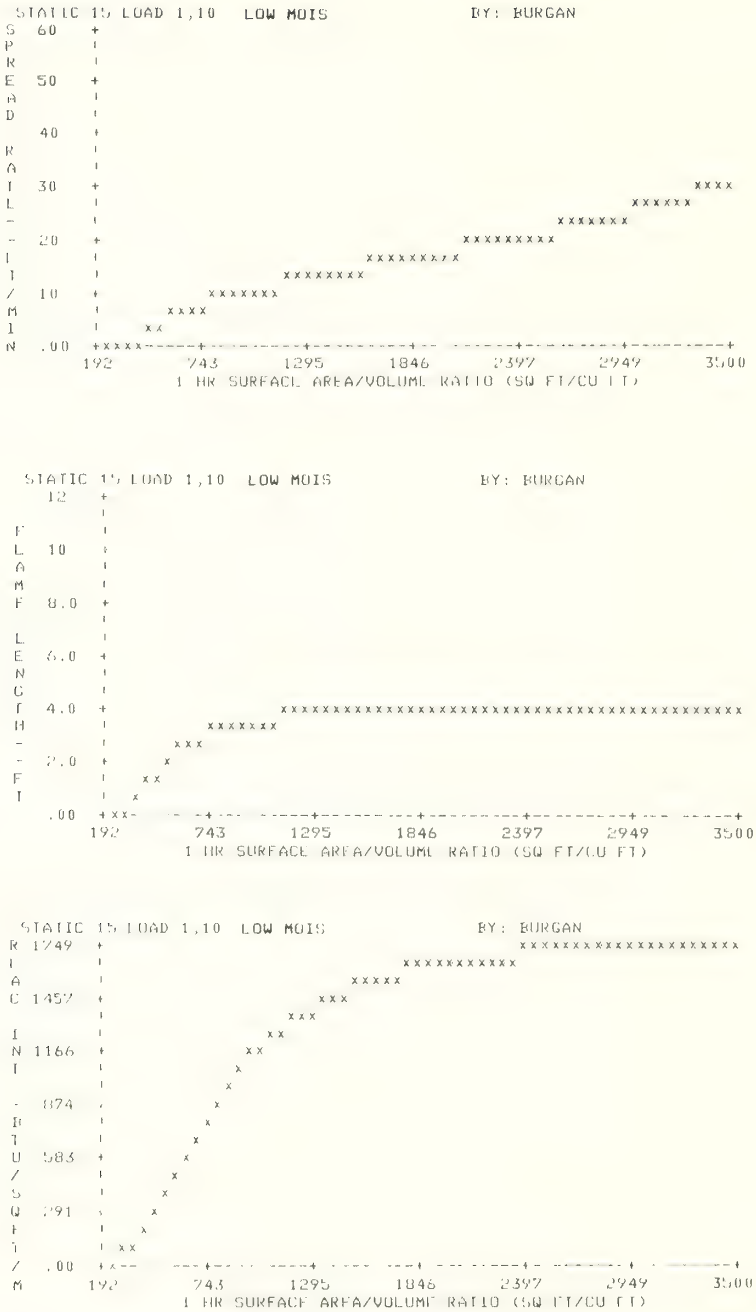


Figure 15—One-hour surface area/volume ratio, example 2.

S/V Effects—Reaction intensity, propagating flux ratio, wind, and slope coefficients all increase as the S/V ratio increases; that is, all the parameters in the numerator increase. The heat sink (denominator) will also increase because a larger proportion of each fuel particle is heated to ignition temperature when flaming combustion starts. In general, the effects in the numerator will dominate so the spread rate, flame length, and reaction intensity tend to increase (fig. 15). But in a model that has a low load of fine dead fuels (at a relatively low moisture content) and a heavy load of live fuels (at a relatively high moisture content), an increase of the live fuel S/V ratio may actually decrease spread rate, etc., because the heat sink effects could dominate in that case.

Extinction Moisture, Heat Content Effects—The effects of extinction moisture and heat content are similar to example 1 and so will not be discussed.

Example 3

Example 3 has a load of 1 ton/acre in each of the 1-, 10-, and 100-h classes as shown in the following tabulation:

Fuel Model Test Run—User-Defined Environmental Inputs

Static 16. Load 1, 10, 100 By: Burgan

Load (T/AC)		S/V Ratios		Other	
1 HR	1.00	1 HR	2000.	Depth (feet)	0.50
10 HR	1.00	Live herb	0.	Heat content (Btu/lb)	8000.
100 HR	1.00	Live woody	0.	Ext moisture (%)	25.
Live herb	0.00	Sigma	1876.	Packing ratio	0.00861
Live woody	0.00	S/V = (sqft/cuft)		PR/OPR	1.23

Environmental Data		Fire Behavior Results: Fire Variable	Midflame Wind 0.	4.	8.
1 HR FM	3.				
10 HR FM	4.				
100 HR FM	5.	ROS (ft/m)	3.	11.	27.
Live herb FM	70.	FL (ft)	2.	3.	5.
Live woody FM	70.	IR (Btu/sq ft/m)	1649.	1649.	1649.
		H/A (Btu/sq ft)	338.	338.	338.
Slope (%)	30.	FLI (Btu/ft/sec)	16.	64.	150.

The optimum packing ratio for this model is 0.0070 and the optimum loading is 2.44 tons/acre.

Load Effects (1-h and 10-h)—The effects of increasing 1-h (fig. 16) and 10-h (fig. 17) fuel loads are very similar to example 2 and for the same reasons, so these will not be discussed further.

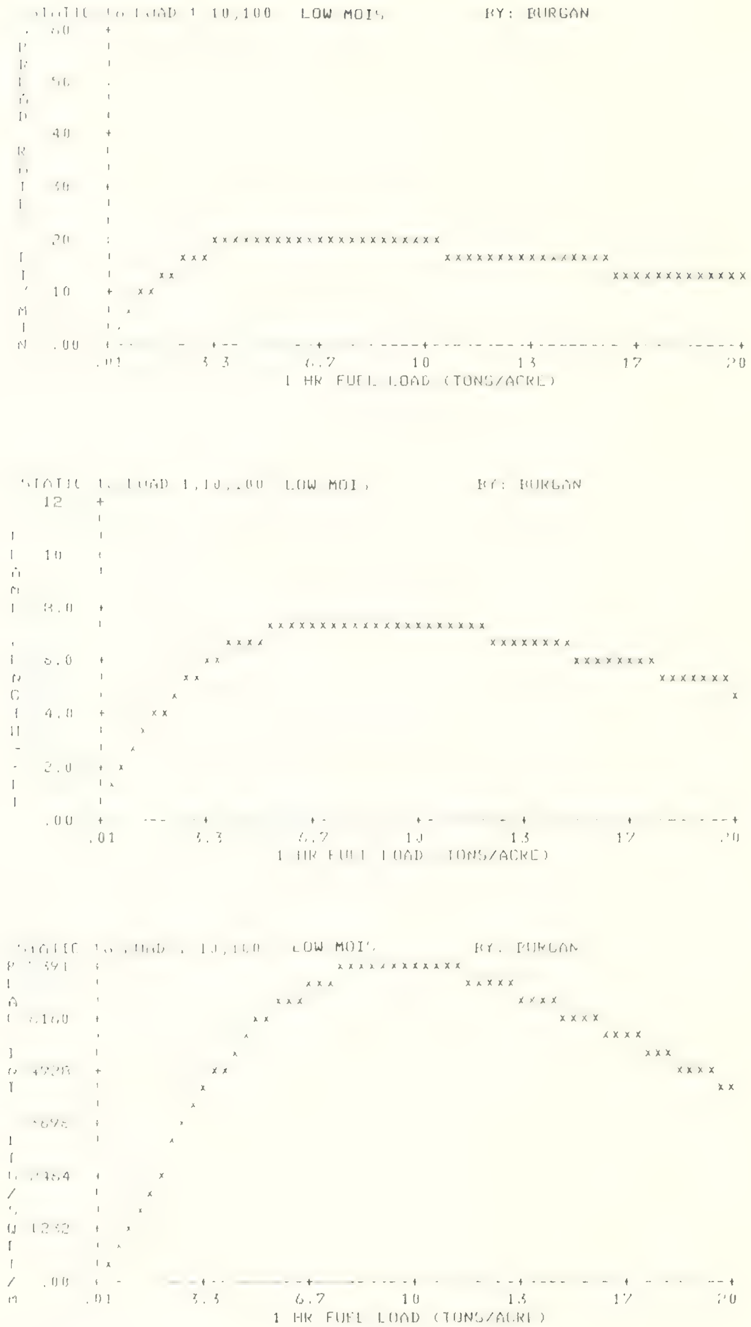
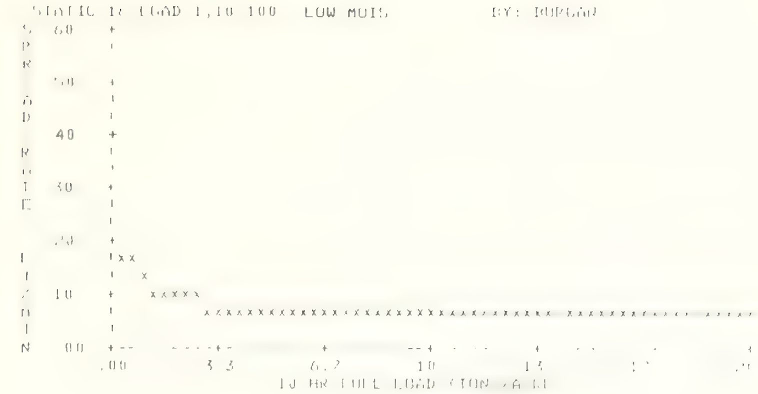
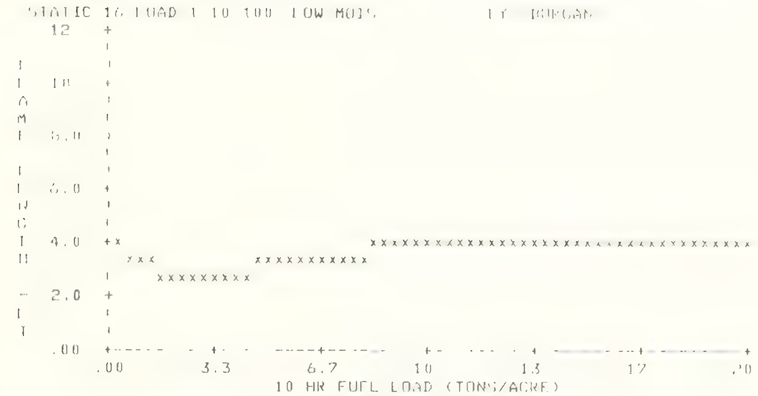


Figure 16—One-hour fuel load, example 3.





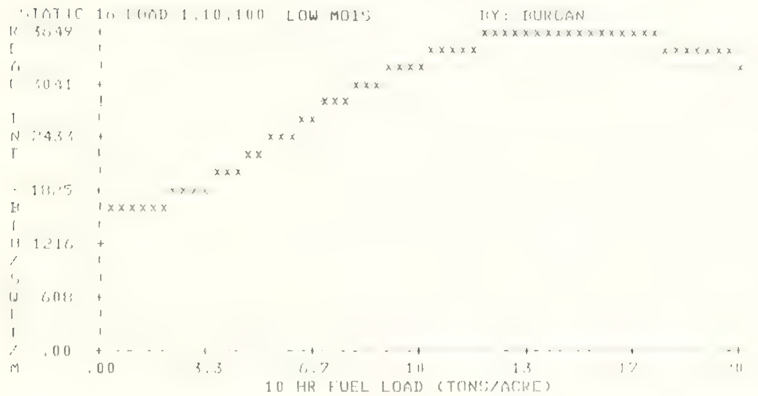


Figure 17—Ten-hour fuel load, example 3.

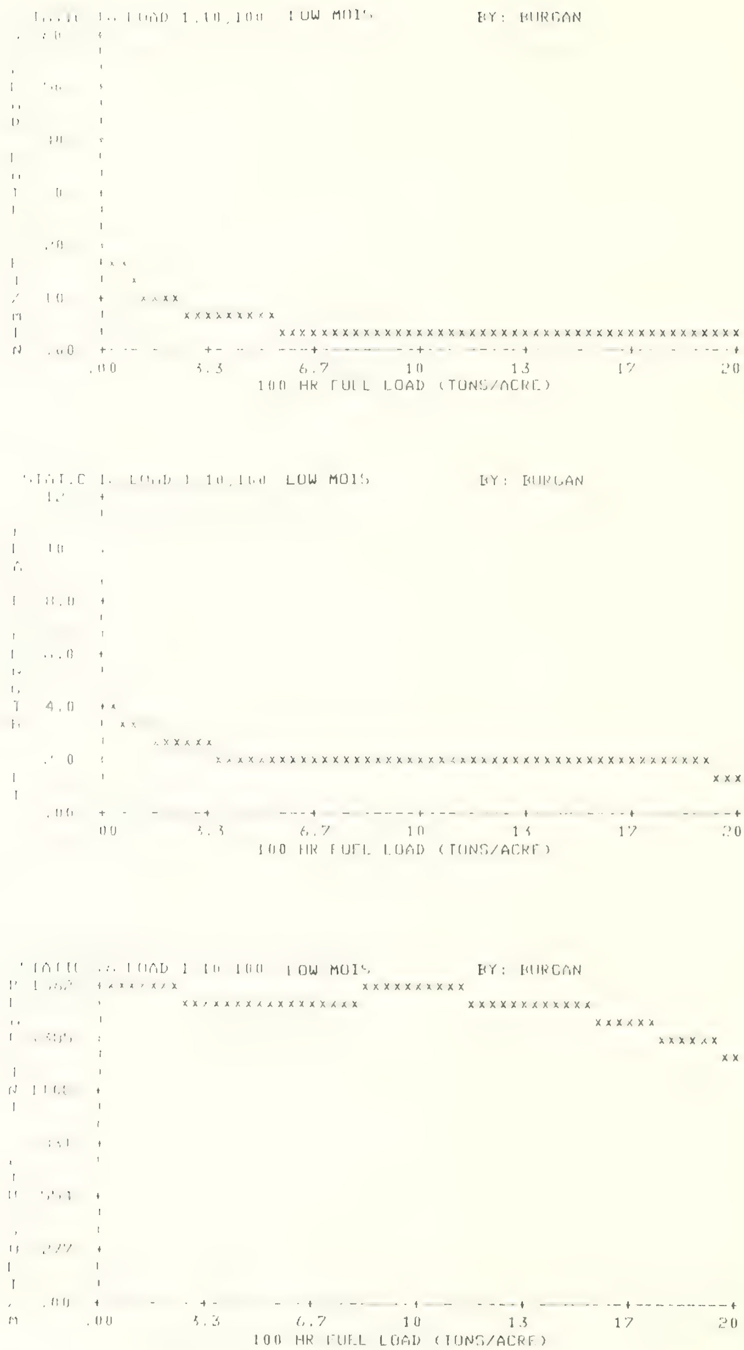


Figure 18—One hundred-hour fuel load, example 3.

Load Effects (100-h)—The effect of adding 100-h fuel to any model is similar to that of adding 10-h fuel. Spread rate and flame length decrease (fig. 18) primarily because the low S/V ratio of the 100-h fuels decreases the characteristic S/V ratio for the model as a whole. This also shifts the peak reaction velocity toward high packing ratios. In this case, the 100-h fuel has only slight effect on the reaction intensity (fig. 18) until so much 100-h load is added that the fuel bed becomes tightly packed and the reaction intensity begins to decline.

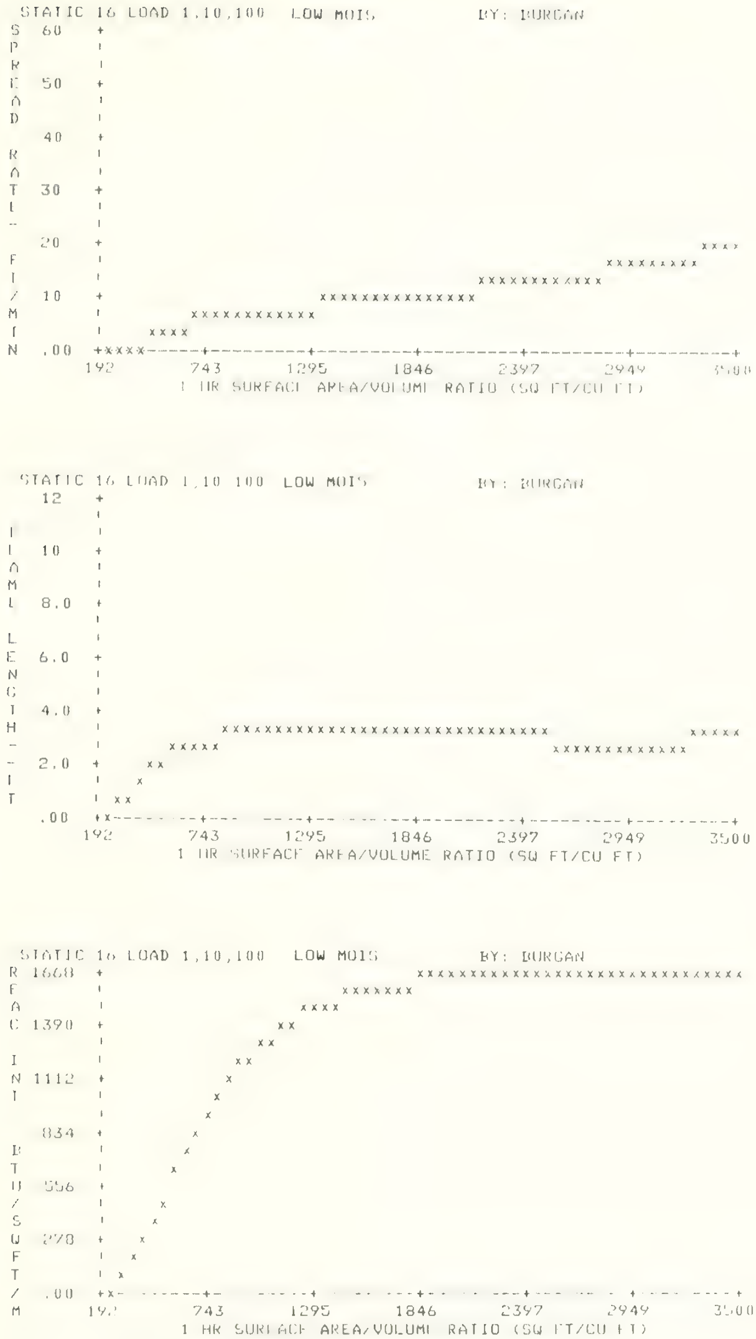


Figure 19—One-hour surface area/volume ratio, example 3.

S/V Ratio Effects—Increasing the S/V ratio of 1-h fuels has the same effect on a fuel model that has 100-h fuel in it as one that does not. That is, predicted fire behavior outputs generally increase (fig. 19).

Example 4

For the fourth example, 1 ton/acre of herbaceous fuel is added. Note that this is a static model. The data are given in the following tabulation:

Fuel Model Test Run—User-Defined Environmental Inputs

Static 17. Load 1, 10, 100, herb By: Burgan

Load (T/AC)		S/V Ratios		Other	
1 HR	1.00	1 HR	2000.	Depth (feet)	0.50
10 HR	1.00	Live herb	2000.	Heat content (Btu/lb)	8000.
100 HR	1.00	Live woody	0.	Ext moisture (%)	25.
Live herb	1.00	Sigma	1936.	Packing ratio	0.01148
Live woody	0.00	S/V = (sqft/cuft)		PR/OPR	1.69

Environmental Data		Fire Behavior Results: Fire Variable	Midflame Wind 0.	4.	8.
1 HR FM	3.				
10 HR FM	4.				
100 HR FM	5.	ROS (ft/m)	2.	7.	16.
Live herb FM	70.	FL (ft)	2.	3.	5.
Live woody FM	70.	IR (Btu/sq ft/m)	2993.	2993.	2993.
		H/A (Btu/sq ft)	594.	594.	594.
Slope (%)	30.	FLI (Btu/ft/sec)	17.	66.	157.

The optimum packing ratio is 0.0068 and the optimum loading is 2.37 tons/acre.

Load Effects (1-h Varies)—The addition of 1-h load increases spread rate, flame length, and reaction intensity until the packing ratio gets so high the reaction velocity starts to decrease. Then these fire behavior predictors also decrease (fig. 20).

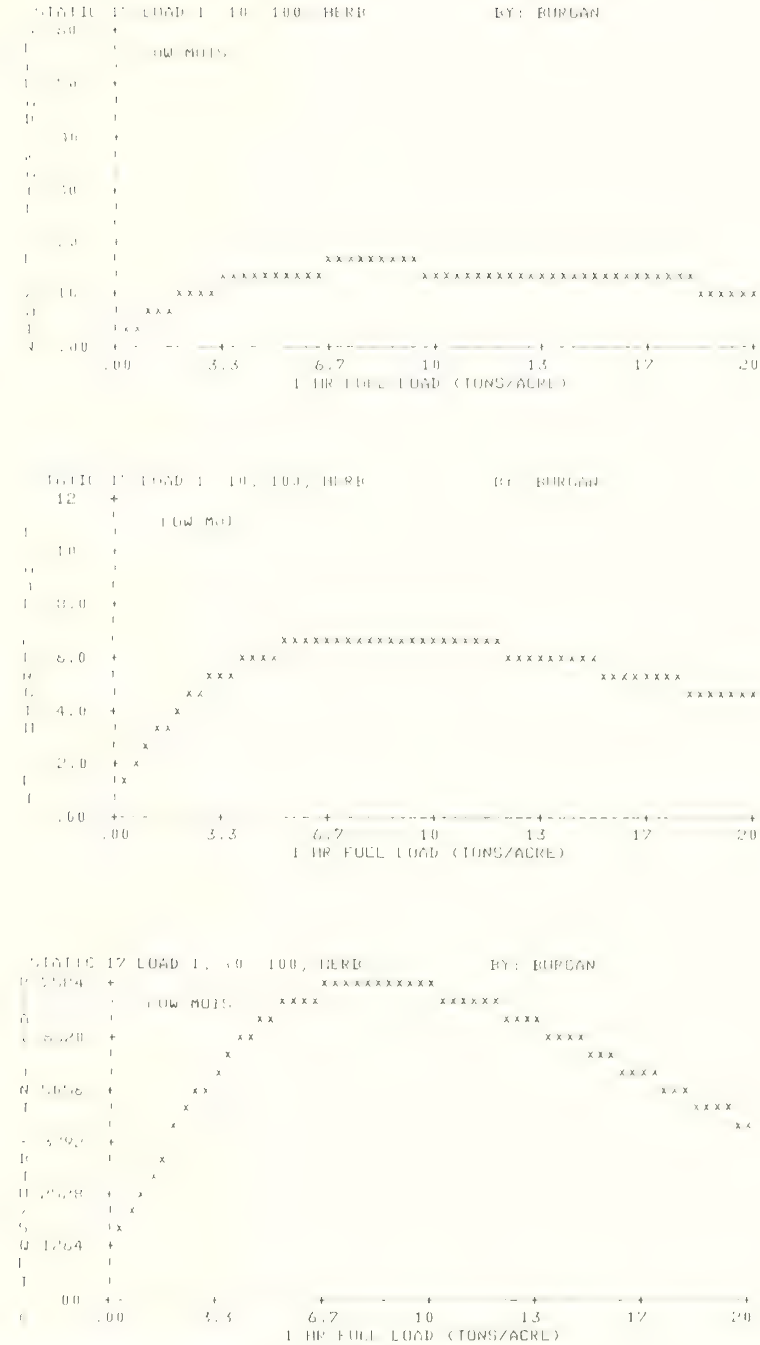


Figure 20—One-hour fuel load, example 4.

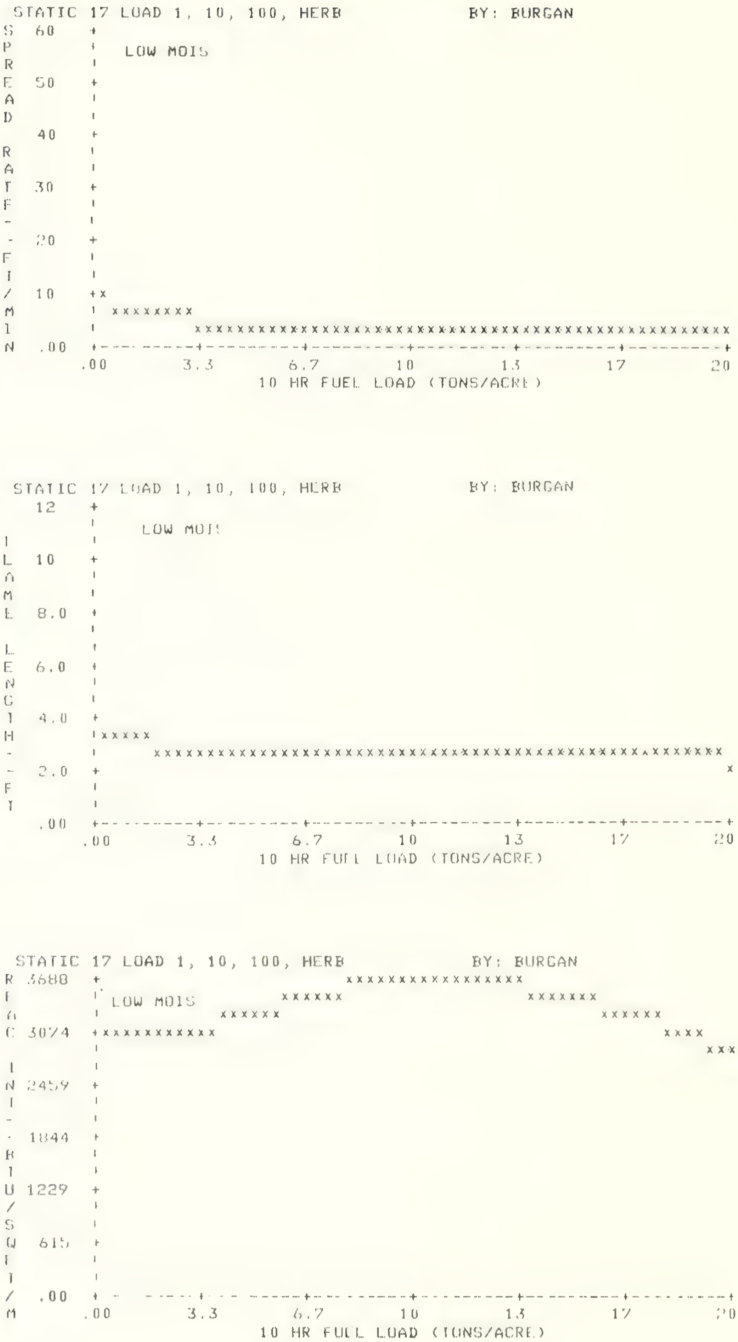


Figure 21—Ten-hour fuel load, example 4.

Load Effects (10-h Varies)—Again, addition of 10-h fuel decreases spread rate because it decreases the S/V ratio of the model and thus ϕ_w, ϕ_s and the reaction velocity (fig. 21).

The reaction intensity increases to a maximum at a rather high load of about 10 tons/acre because the characteristic S/V ratio is decreasing; thus the optimum packing ratio advances to a rather high fuel load.

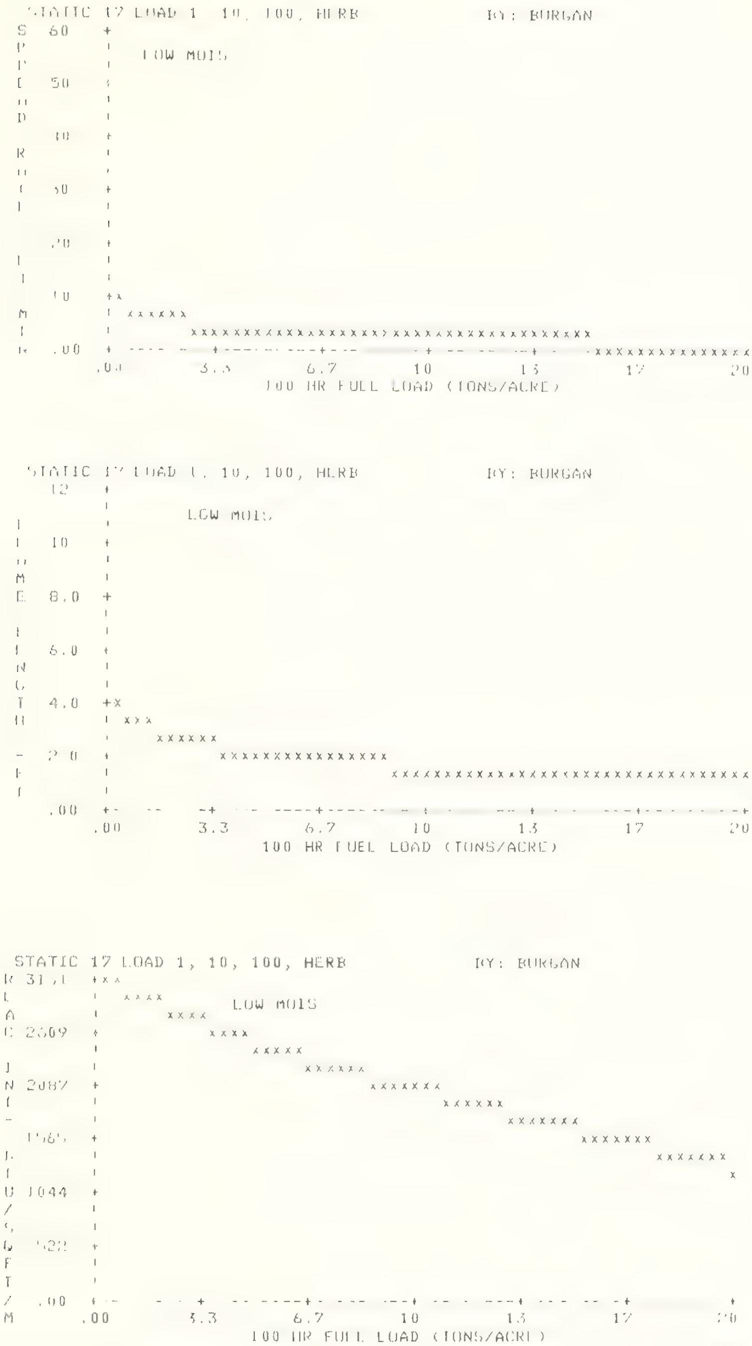
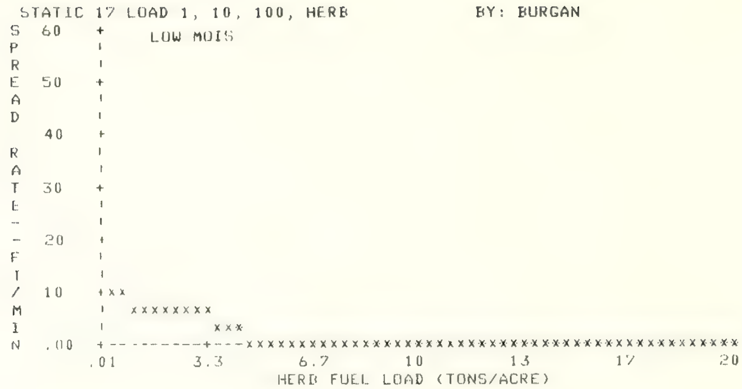
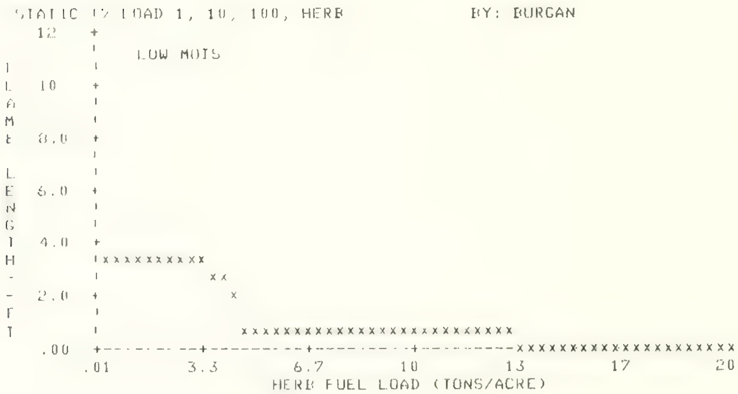


Figure 22—One hundred-hour fuel load, example 4.

Load Effects (100-h Varies)—Again, addition of 100-h fuels decreases the S/V ratio for the model and thus the fire behavior outputs (fig. 22).





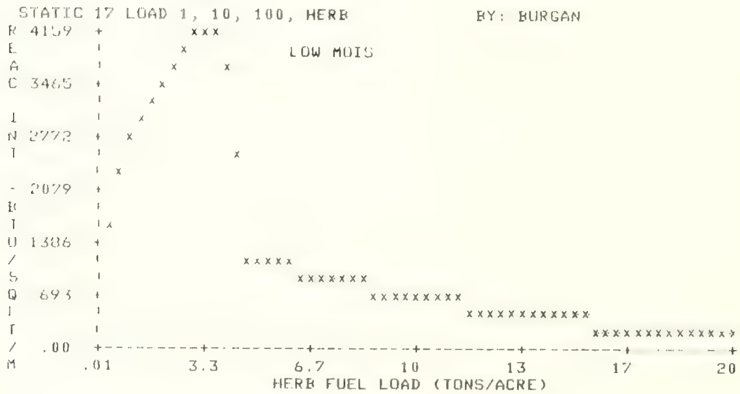


Figure 23—Herbaceous fuel load, example 4.

Load Effects (Herb Varies)—Spread rate decreases because an increasing amount of live fuel, which has a high moisture content, is being dumped into the model (fig. 23). The heat sink is increasing fast.

Reaction intensity increases for a time because the dead fuels generate enough heat to ignite the live fuels, which also contribute to the rate of combustion. At about 4 tons/acre, the live fuels suddenly stop becoming a heat source and serve entirely as a heat sink, so the reaction intensity decreases rapidly (fig. 23).

The decline in flame length results from a decrease in both spread rate and, particularly, reaction intensity (fig. 23).

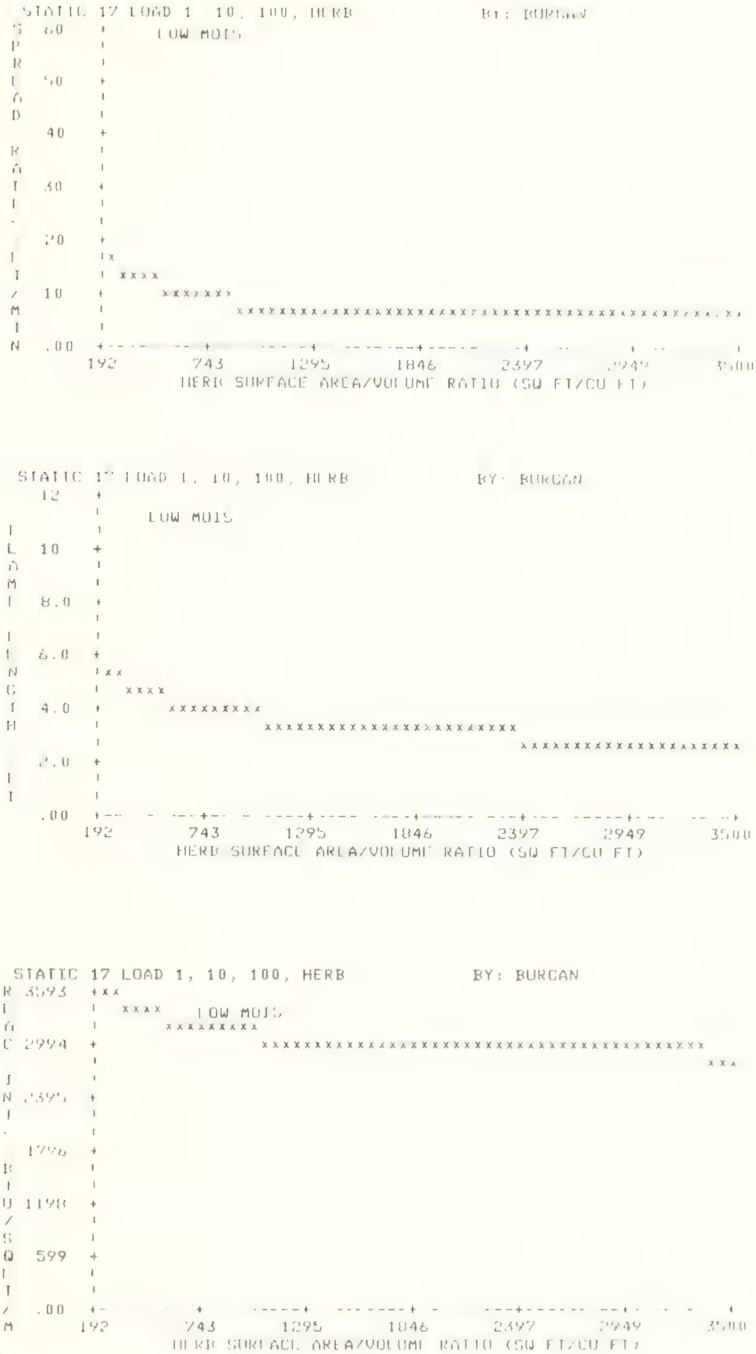


Figure 24—Herbaceous surface area/volume ratio, example 4.

S/V Ratio Effects (1-h and Herbaceous)—An increase of 1-h S/V ratio acts in this model as in the previous ones—it increases the fire behavior predictions. It is more interesting to look at the effect of increasing the S/V ratio of the herbaceous fuels. Remember in example 2 it was noted that increasing the S/V ratio for high moisture content live fuels could **reduce** rather than **increase** the fire behavior predictions? Why? Primarily because as the live fuel particle size decreases, the proportion of the live fuel that must be heated to ignition increases. And this stuff is wet! So the heat sink goes up and the fire behavior goes down (fig. 24).

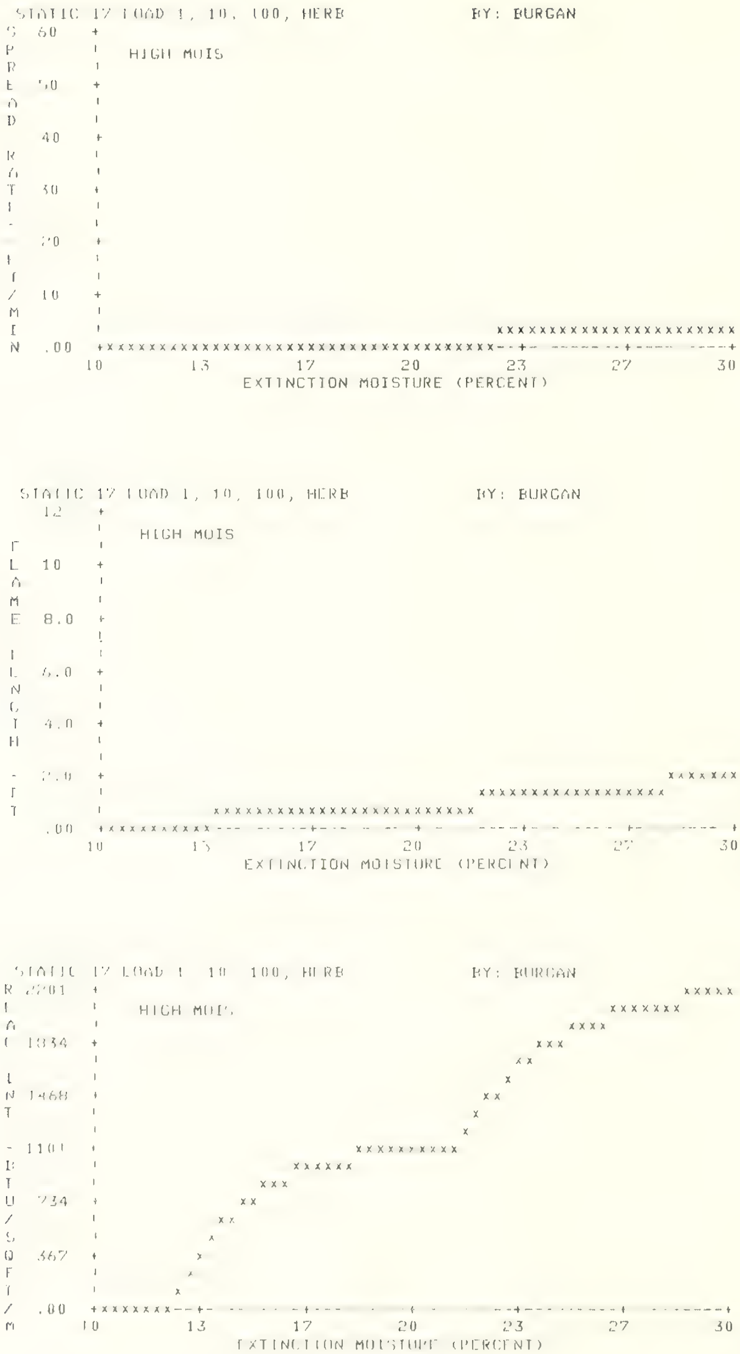


Figure 25—Extinction moisture, example 4.

Extinction Moisture Effect—When the extinction moisture for dead fuels is changed, the moisture damping coefficient (η_m) does **not** remain constant as we suggested earlier. Increasing the moisture of extinction moves us to the left on the moisture damping curve (fig. 6). Since η_m is a multiplier, the closer it is to 1, the less the damping effect. Increasing the extinction moisture (M_x) reduces the ratio of M_f/M_x, where M_f is the moisture fraction of the actual fuels. The reaction intensity curve has the same general S shape as the moisture damping curve (fig. 25).

Example 5 (1-h, Herb-static) and Example 6 (1-h, Herb-dynamic)

These two examples are discussed together so the effects of static vs. dynamic models can be easily compared. Note that there is now 1 ton/acre in just the 1-h and live herbaceous classes. The only difference between the models is that one is static and one is dynamic. They are presented in the following tabulation:

Fuel Model Test Run—User-Defined Environmental Inputs

Static 18. Load 1, herb — By: Burgan

Load (T/AC)		S/V Ratios		Other	
1 HR	1.00	1 HR	2000.	Depth (feet)	0.50
10 HR	0.00	Live herb	2000.	Heat content (Btu/lb)	8000.
100 HR	0.00	Live woody	0.	Ext moisture (%)	25.
Live herb	1.00	Sigma	2000.	Packing ratio	0.00574
Live woody	0.00	S/V = (sqft/cuft)		PR/OPR	0.87

Environmental Data		Fire Behavior Results: Fire Variable	Midflame Wind 0.	4.	8.
1 HR FM	3.				
10 HR FM	4.				
100 HR FM	5.	ROS (ft/m)	3.	14.	35.
Live herb FM	70.	FL (ft)	2.	4.	7.
Live woody FM	70.	IR (Btu/sq ft/m)	3058.	3058.	3058.
		H/A (Btu/sq ft)	587.	587.	587.
Slope (%)	30.	FLI (Btu/ft/sec)	33.	138.	338.

Fuel Model Test Run—User-Defined Environmental Inputs

Dynamic 18. Load 1, herb — By: Burgan

Load (T/AC)		S/V Ratios		Other	
1 HR	1.00	1 HR	2000.	Depth (feet)	0.50
10 HR	0.00	Live herb	2000.	Heat content (Btu/lb)	8000.
100 HR	0.00	Live woody	0.	Ext moisture (%)	25.
Live herb	1.00	Sigma	2000.	Packing ratio	0.00574
Live woody	0.00	S/V = (sqft/cuft)		PR/OPR	0.87

Environmental Data		Fire Behavior Results: Fire Variable	Midflame Wind 0.	4.	8.
1 HR FM	3.				
10 HR FM	4.				
100 HR FM	5.	ROS (ft/m)	6.	23.	57.
Live herb FM	70.	FL (ft)	3.	6.	9.
Live woody FM	70.	IR (Btu/sq ft/m)	3455.	3455.	3455.
		H/A (Btu/sq ft)	663.	663.	663.
Slope (%)	30.	FLI (Btu/ft/sec)	61.	258.	630.

The optimum packing ratio is 0.00066; the optimum loading is 2.3 tons/acre.

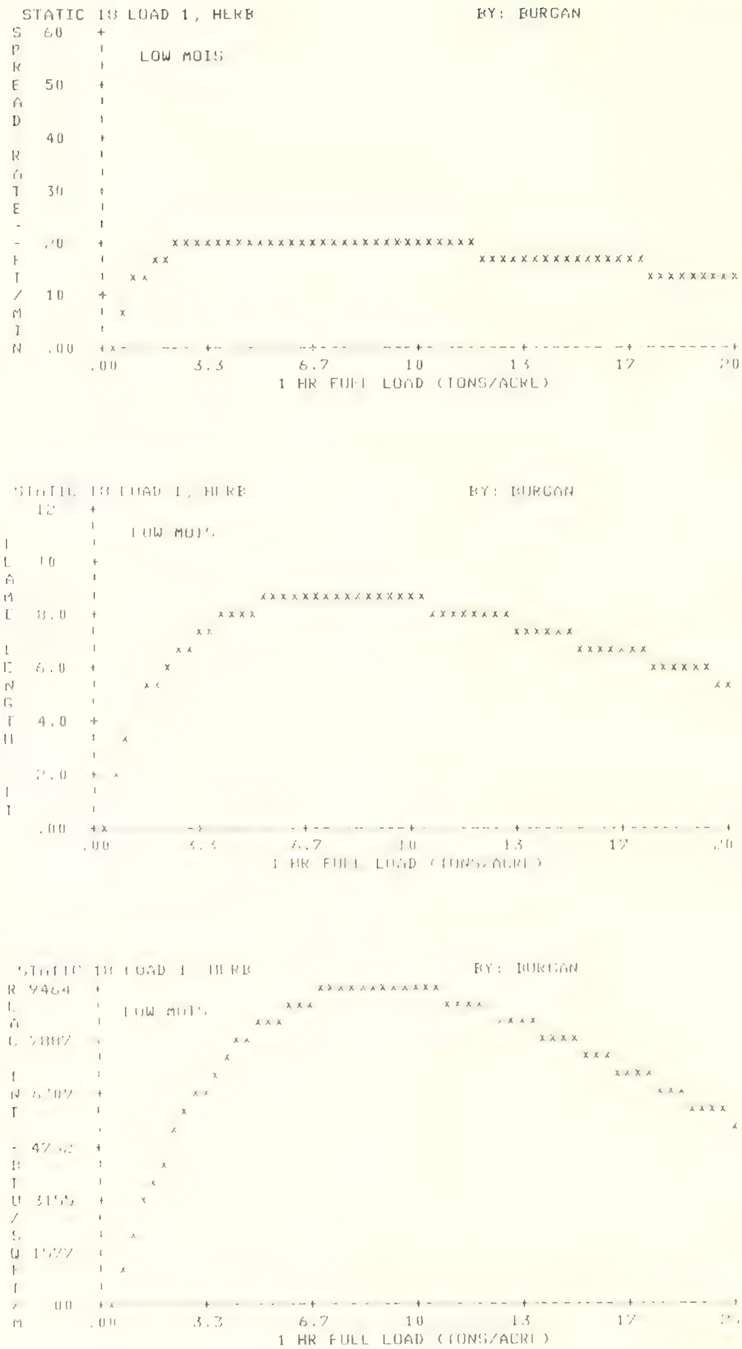


Figure 26—One-hour fuel load, example 5.

Load Effects (1-h, Static)—In this case, the spread rate stops increasing at about the optimum loading (2.3 tons/acre) (fig. 26). Above this load, the reaction velocity is decreasing. Also ϕ_w and ϕ_s are decreasing because the packing ratio (β) is increasing, as is the heat sink. These effects prevent the spread rate from increasing even though the reaction intensity continues to increase for some time because of the added fuel.

Flame length is a function of both spread rate and reaction intensity, so peaks at a load somewhere between the loads at which these two parameters peak (fig. 26).

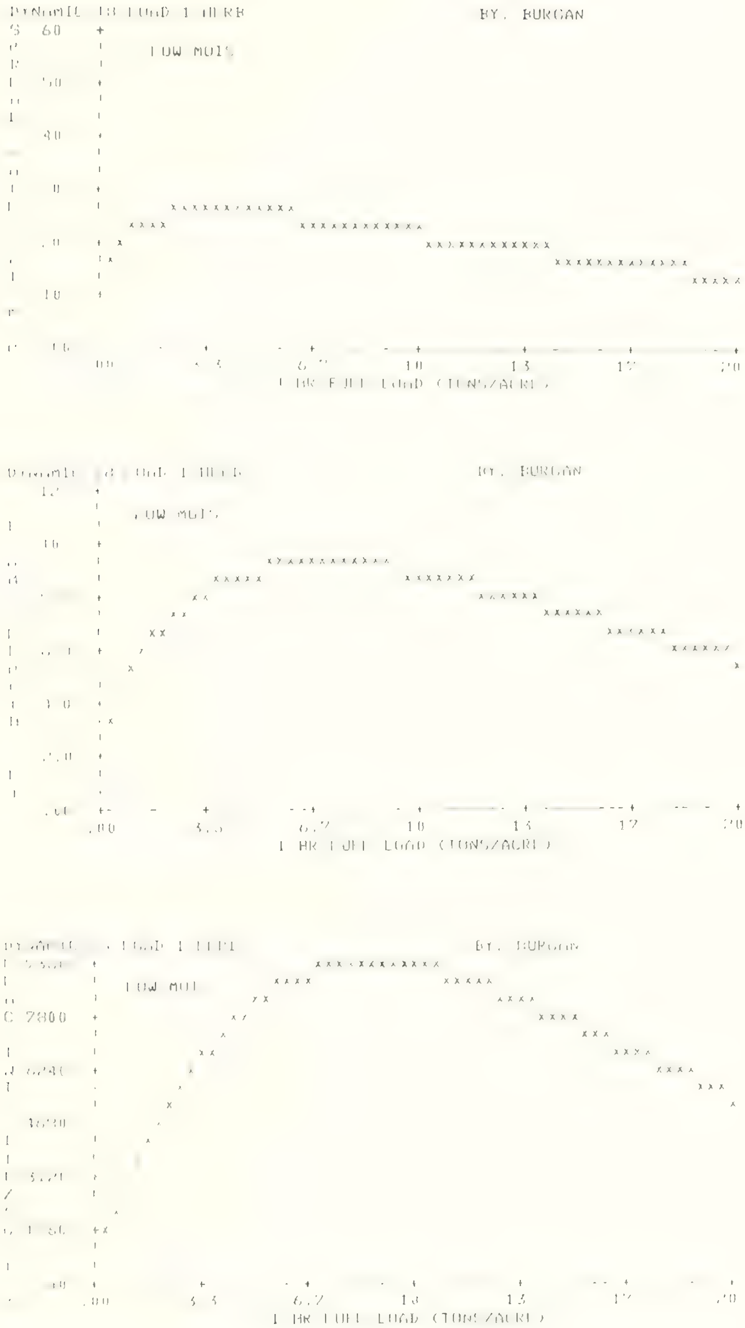


Figure 27—One-hour fuel load, example 6.

Load Effects (1-h, Dynamic)—Because the herbaceous moisture is 70 percent, part of the live herbaceous fuel is transferred to the 1-h class. Thus we do not have a model with 1 ton/acre of 1-h load and 1 ton/acre of herb load as advertised, but rather one with 0.55 ton/acre of herb load transferred to the 1-h class. The percentage transferred from the live herbaceous to the 1-h class is:

$$(-0.0111 * \text{HFM} + 1.33) * 100$$

In our case HFM = 70 percent so the percent transferred is:

$$(-0.0111 * 70 + 1.33) * 100 = 55 \text{ percent}$$

Thus, with a higher 1-h load to start with (1.55 tons/acre), a comparison of figure 27 with figure 26 shows the dynamic model predicts greater spread rates, flame lengths, and reaction intensity than does the static model.

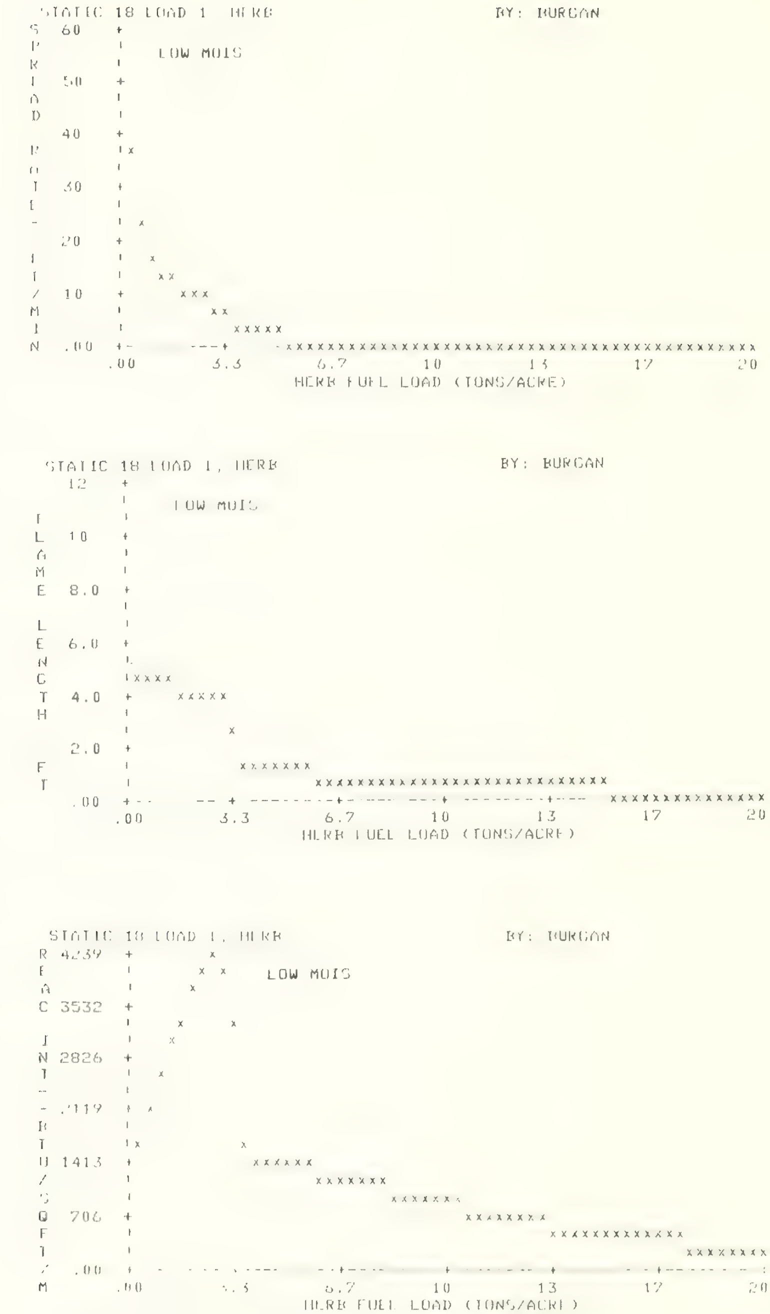


Figure 28—Herbaceous fuel load, example 5.

Load Effects (Herb-static)—The addition of herbaceous fuel to this static model has the same effect as described in example 4 and for the same reasons (fig. 28).

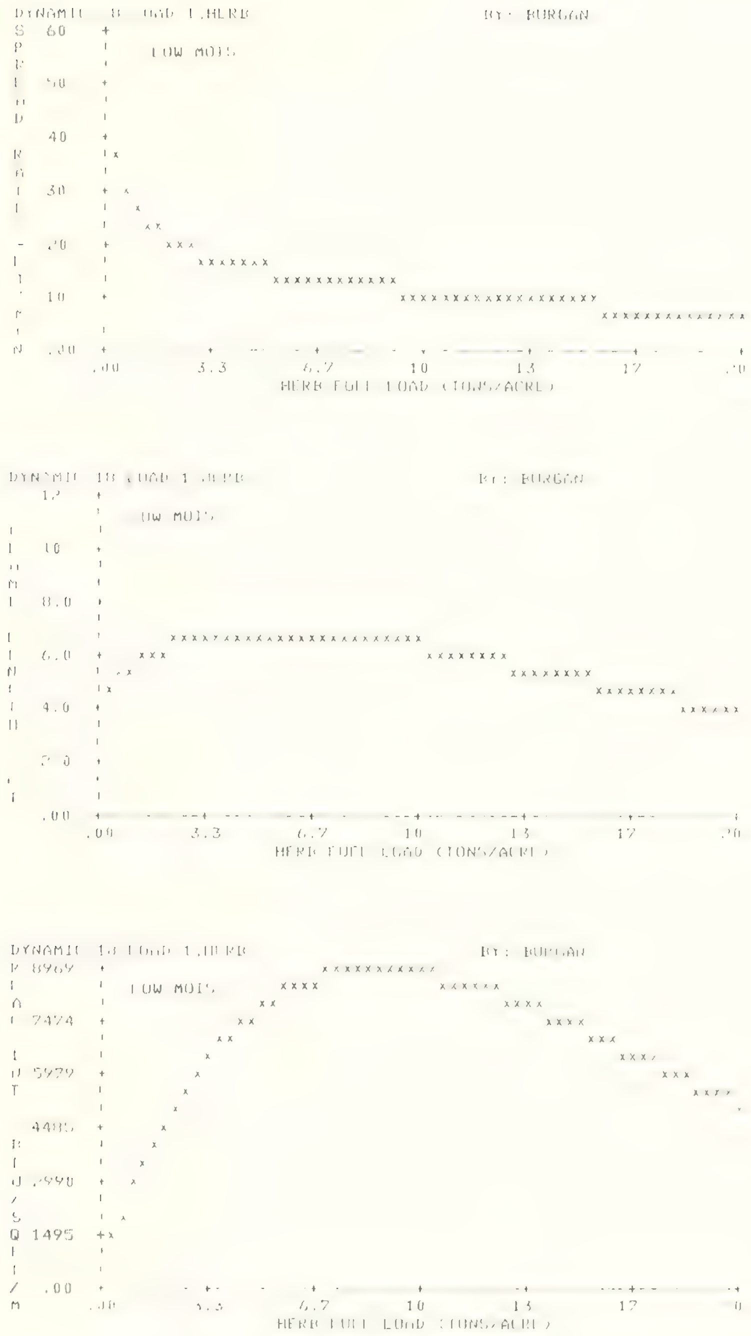


Figure 29—Herbaceous fuel load, example 6.

Load Effects (Herb-dynamic)—Because this is a dynamic model, the addition of herbaceous fuels (with a moisture content less than 120 percent) means that we are also adding to the 1-h fuel load. Thus the reaction intensity curve (fig. 29) is similar to the first example (1-h load only) except that reaction intensity peaks a little sooner because of the influence of some live (and wet) herbaceous fuel.

Spread rate decreases (fig. 29) for the same reasons given in example 1 (decreasing ϕ_w and ϕ_s and increasing heat sink).

Flame length reacts similarly (fig. 29) to example 1.

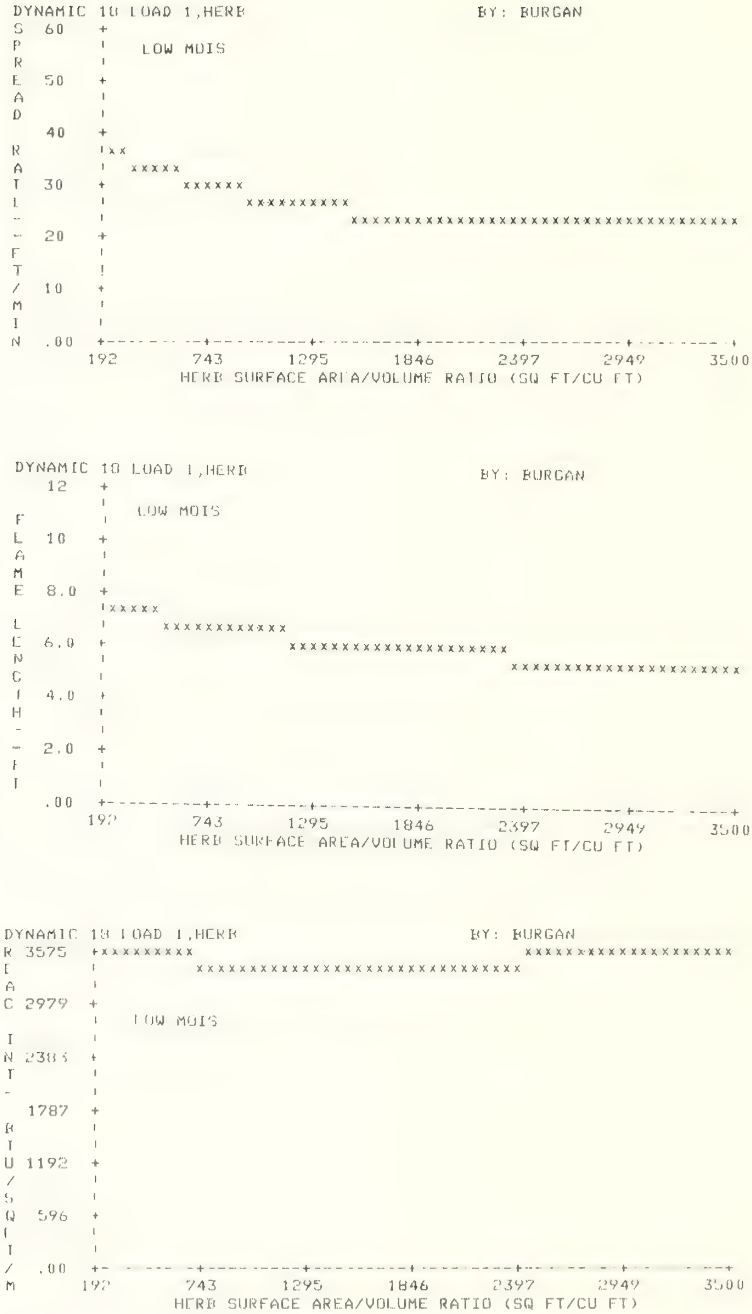


Figure 30—Herbaceous surface area/volume ratio, example 6.

S/V Ratio Effects—Again, increasing the S/V ratio of these relatively wet fuels increases the heat sink enough to overpower the effect of an increasing σ on ϕ_w, ϕ_s and Γ'. Note, however, that the predicted fire behavior for the dynamic model (fig. 30) decreases more slowly than for the static model (fig. 31). This is because there are actually 1.55 tons/acre of 1-h fuels and 0.45 ton/acre of live herbaceous fuels in the dynamic model when the herbaceous moisture is 70 percent.

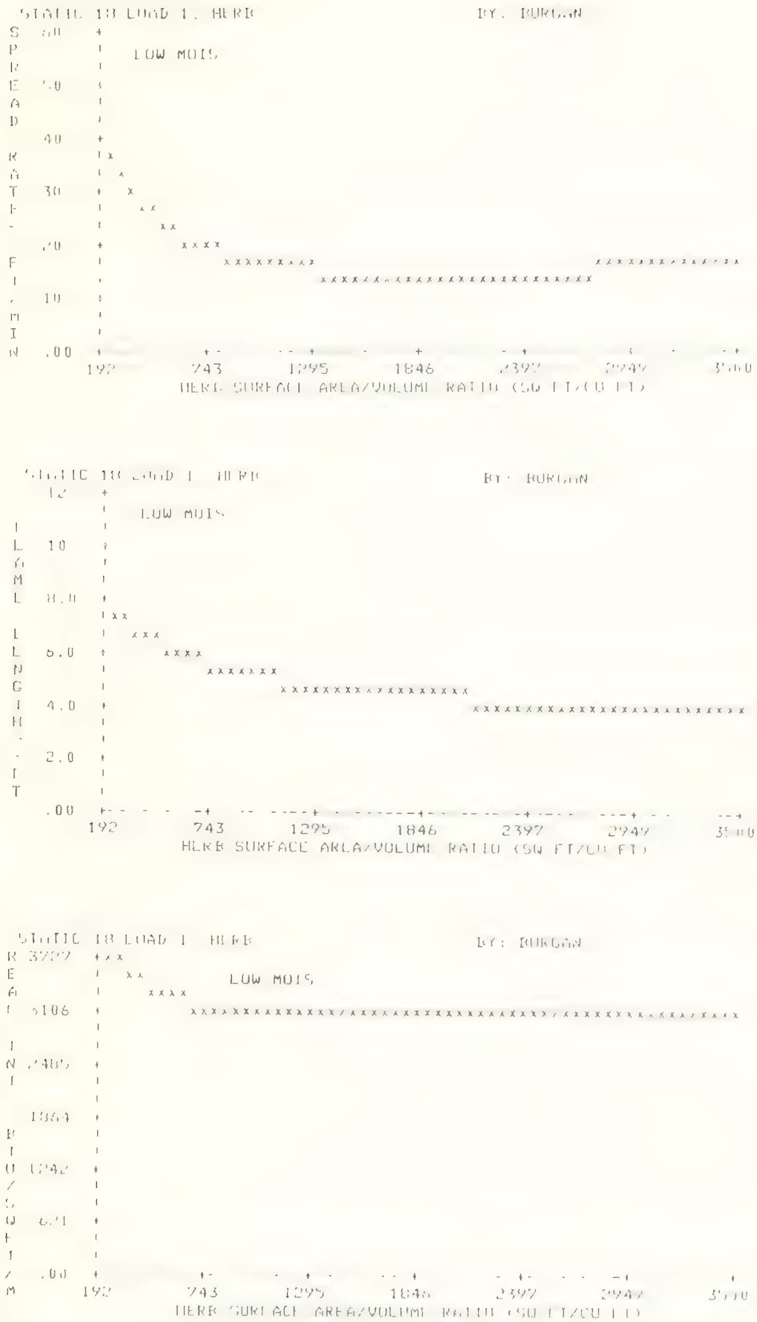


Figure 31—Herbaceous surface area/volume ratio, example 5.

FUEL MODELING EXERCISE

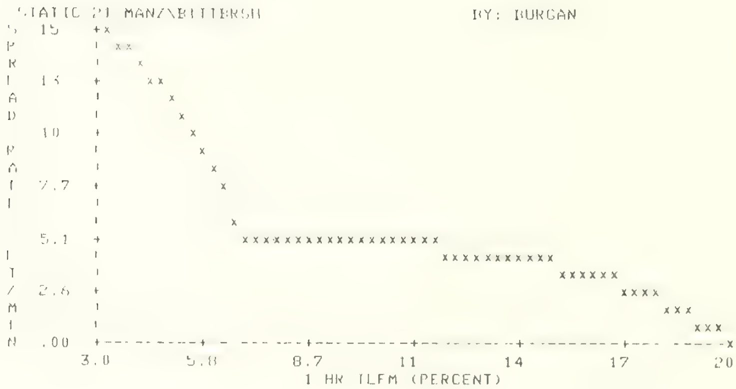
Although the local fire manager must develop models to represent specific fuels, an exercise is presented here to help reinforce the fuel modeling concepts discussed earlier. This exercise grew out of a need to model a particular shrub type, but the approach to the problem may be applicable to other vegetation types that have a large component of living vegetation.

The specific vegetation is a bitterbrush/chaparral type, with a negligible amount of grass. The bitterbrush has a total load of 13.84 tons/acre, of which 19.9 percent is 1-h, 28.9 percent is 10-h, 7.3 percent is 100-h, and 43.9 percent is live. The chaparral has a total load of 3.10 tons/acre, of which 16.1 percent is 1-h, 16.1 percent is 10-h, 0.0 percent is 100-h, and 67.8 percent is live. The bitterbrush has a significantly lower S/V ratio than the chaparral.

```
CURRENT USER DEFINED ENVIRONMENTAL PARAMETERS

STATIC 21. MANZ\BITTBRSH                    BY: BURGAN

        MOISTURES (%)                        OTHER
     ----------------------        ----------------------------
     1 HR              6.          MIDFLAME WIND (MPH)      4.
     10 HR             7.          SLOPE (PERCENT)         30.
     100 HR            8.
     LIVE HERB       120.
     LIVE WOODY      120.
```



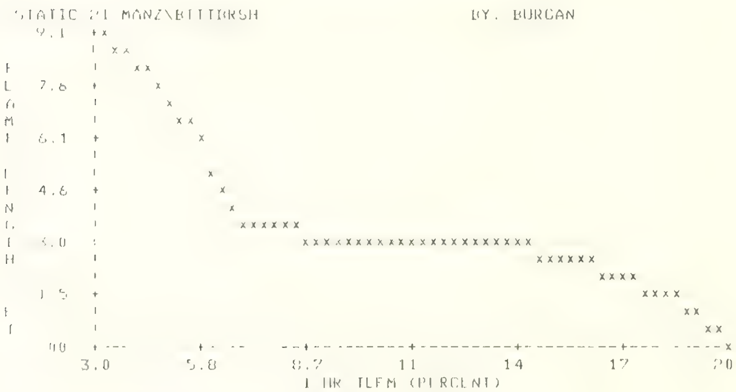


Figure 32—Fuel modeling exercise.

Your task is to produce a fuel model for this type such that its predicted fire behavior approximates that shown in the following tabulation and in figures 32 and 33. Use the environmental inputs provided with the tabulation and the figures. You will have to be innovative to match the solution.

Environmental Data		Fire Variable	Fire Behavior Results — Midflame Wind 0.	4.	8.
1 HR FM	3.				
10 HR FM	4.				
100 HR FM	5.	ROS (ft/m)	7.	28.	61.
Live herb FM	70.	FL (ft)	7.	13.	19.
Live woody FM	70.	IR (Btu/sq ft/m)	13836.	13836.	13836.
		H/A (Btu/sq ft)	3341.	3341.	3341.
Slope (%)	30.	FLI (Btu/ft/sec)	379.	1553.	3377.

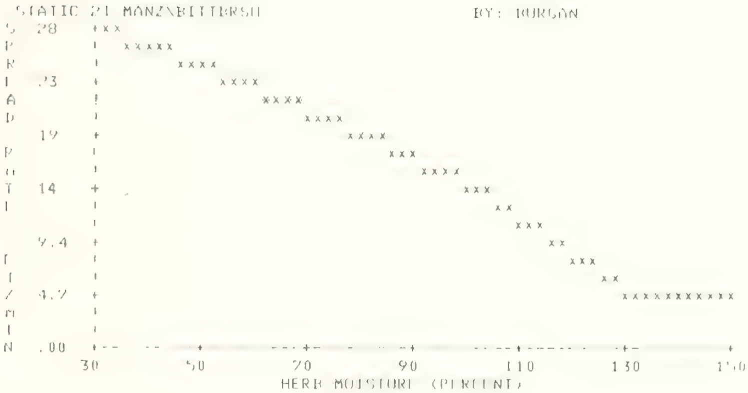
Environmental Data		Fire Variable	Fire Behavior Results — Midflame Wind 0.	4.	8.
1 HR FM	6.				
10 HR FM	7.				
100 HR FM	8.	ROS (ft/m)	2.	8.	17.
Live herb FM	120.	FL (ft)	3.	5.	7.
Live woody FM	120.	IR (Btu/sq ft/m)	5777.	5777.	5777.
		H/A (Btu/sq ft)	1395.	1395.	1395.
Slope (%)	30.	FLI (Btu/ft/sec)	45.	183.	398.

```
CURRENT USER DEFINED ENVIRONMENTAL PARAMETERS

STATIC 21. MANZ/BITTBRSH                         BY: BURGAN

          MOISTURES (%)                          OTHER

          1 HR             6.        MIDFLAME WIND (MPH)      4.
          10 HR            7.        SLOPE (PERCENT)          [illegible]
          100 HR           8.
          LIVE HERB      170.
          LIVE WOODY     120.
```



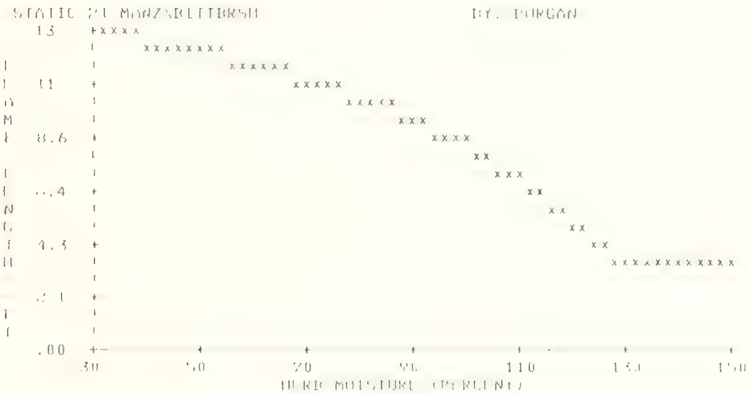


Figure 33—Fuel modeling exercise, continued.

The problem in modeling this fuel type is that because the two shrub types have significantly different surface-area-to-volume ratios, they should be put in separate live fuel classes. Fire behavior fuel models do permit two live fuel classes—conventionally named live herbaceous and live woody. Because the live herbaceous load is negligible, the load and S/V data for one of the shrubs can be put in this fuel class. But the model **must** be "static" because the shrub load placed in the live herbaceous class is **not** going to cure and be transferred to the 1-h class as does the live herbaceous load in a dynamic model.

The solution is given in the following tabulation. The live bitterbrush component was placed in the live herbaceous class and assigned an S/V ratio of 1,250 ft^2/ft^3. The live chaparral load was placed in the live woody class and assigned an S/V ratio of 1,800 ft/ft^3.

Fuel Model Test Run—Standard Environmental Inputs

Static 21. Manz/Bittbrsh — By: Burgan

Load (T/AC)		S/V Ratios		Other	
1 HR	3.26	1 HR	1986.	Depth (feet)	2.50
10 HR	4.50	Live herbaceous	1250.	Heat content (Btu/lb)	7575.
100 HR	1.00	Live woody	1800.	Ext moisture (%)	19.
Live herbaceous	6.08	Sigma	1590.	Packing ratio	0.00972
Live woody	2.10	S/V = (sqft/cuft)		PR/OPR	1.22

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Expands upon the basic concepts of fuel modeling to provide a more complete discussion of the technical details of constructing site-specific fire behavior fuel models.

KEYWORDS: fuels, fire, fire behavior, modeling

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**Intermountain
Research Station**

General Technical
Report INT-239

Fire Response of Shrubs of Dry Forest Habitat Types in Montana and Idaho

Nonan V. Noste
Charles L. Bushey

THE AUTHORS

NONAN V. NOSTE is research forester, Intermountain Fire Sciences Laboratory, Intermountain Research Station, Forest Service, U.S. Department of Agriculture, Missoula, MT. Mr. Noste has conducted research in fire control and fire effects for the Forest Service and is currently involved in wilderness fire management study.

CHARLES L. BUSHEY received his B.A. in biology from Monmouth College in 1973 and his M.S. in botany from Southern Illinois University, Carbondale, in 1985. He is currently a research plant ecologist with Systems for Environmental Management and a prescribed fire specialist/fire ecologist with Montana Prescribed Fire Services, Inc., Missoula, MT. He has been the principal investigator for numerous cooperative studies on forest and sagebrush/grassland fuels, fire behavior, and vegetational response to fire. He was previously employed by the Fire Effects and Use Research and Development Program at the Northern Forest Fire Laboratory, Missoula, MT; NALCO Environmental Sciences, Northbrook, IL; and the Lake County Forest Preserve District, Libertyville, IL.

RESEARCH SUMMARY

Information on biological attributes and response to fire has been summarized for 20 shrub species associated with dry forest habitat types of Idaho and Montana.

The effect of fire on shrubs is an important element in planning prescribed fire treatments designed to modify the shrub component of a stand. Information on individual species' biological attributes and response following fire has been synthesized from literature sources.

Foresters responsible for planning fire management and specifying burn objectives need such information to design prescribed fire treatments that alter the shrub component of a stand.

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Ogden, UT 84401

Fire Response of Shrubs of Dry Forest Habitat Types in Montana and Idaho

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INTRODUCTION

This report summarizes shrub characteristics and fire response information for managers to use in writing fire prescriptions. The shrub component of a stand can be enhanced or depleted by prescribed fire if the manager understands the biology of the species. Knowing that ceanothus stores seed for long periods onsite and that heat treatment induces germination helps identify sites with potential for reestablishment. Ecotypes of antelope bitterbrush resprout differently after fire; some resprout while others do not. Vegetative resprouting of bearberry is rare after fire and its resistance is low to moderate, contrasted to willow or serviceberry, which are high because of their ability to resprout. Prescriptions that include seasonal timing and control of fire severity permit treatments to exploit the biology of the species with different response potential. The basic biology of important species is known to some degree. But such information is widely dispersed throughout the literature and therefore not easily accessible to managers. This paper serves to provide the manager with a ready source of published information on shrubs of dry habitat types.

Guides for writing fire prescriptions to alter vegetation require information on how plants respond to fire treatment. Rooting habit, regeneration capabilities, and phenology are plant attributes important to consider when using fire. Shrub response is of concern to managers where such plants are important browse for wildlife and cattle, provide thermal and hiding cover for wildlife, and may potentially compete with tree seedlings. Foresters developing and executing prescribed fire programs are often less familiar and less experienced with shrub species than they are with trees.

The species included in this report are shrubs associated with the drier forested habitats of western Montana and Idaho. Important shrub species from the *Pinus flexilis*, *Pinus ponderosa*, and *Pseudotsuga menziesii* habitat types (Pfister and others 1977; Steele and others 1981) were selected. These sites are referred to throughout the text, and are the basis for interpreting and integrating information from studies involving the selected species on both drier and more moist sites.

Various systems have been developed for classifying plants according to how they are adapted to survive fire. Plant species are classified herein by two systems that use somewhat contrasting approaches. The first approach, from Lyon and Stickney (1976), associates a fire survival strategy with a given type of response, that is, "increase" or "decrease." The fire survival strategies are (1) surviving plant parts, (2) onsite seeds, and (3) offsite seeds. Surviving parts are root crowns, rhizomes, and underground stems. Onsite seed strategies are subdivided as long viability, short viability, and fortuitous (chance) survival. Offsite seed strategies are classified as airborne and other transport. This listing of fire adaptations is used to characterize the fire response of shrub species.

The second concept (Rowe 1983) is based on the source of meristematic plant tissue that perpetuates a species after fire. The following list presents the criteria for assigning a species to a survival strategy on the basis of meristematic tissues, establishment requirements, and long-term persistence. A two-letter code (for example, VI) indicates the regeneration methods of the shrub and a description term ("invader") indicates persistence mode. A summary of species attributes useful in predicting response to fire is provided for reference (table 1).

I. Regeneration method
  A. Mode of regeneration and reproduction
    1. Vegetative based (plant relies on surviving parts to regenerate)
      a. V species - able to resprout if burned in the juvenile stage.
      b. W species - able to resist fire in the adult stage and to continue extension growth after it (though fire may kill juveniles).
    2. Disseminule based (plant relies on seed to reestablish)
      a. D species - with highly dispersed seed
      b. S species - storing long-lived seed in the soil
      c. C species - storing seed in the canopy
    3. Competitive classification
      a. T species - tolerants that can establish immediately after a fire and can persist indefinitely thereafter without further disturbance.
      b. R species - tolerants that cannot establish immediately after disturbance, but must wait until some additional requirement has been met (for instance, shade).
      c. I species - intolerants that can only establish immediately after a fire. Rapid growth pioneers, they tend to die out without recurrent disturbances.

Table 1—Summary of shrub species attributes that determine response following fire treatment

Attributes	AMAL	ARUV	ARTR	BERE	CELE	CEVE	JUNIP	PAMY	PHMA	LIBO
I. Vegetative regeneration										
A. Resprouters										
1. Root crown	X					X		X		
2. Rhizome or underground		X(L)[1]		X					X	X(L)
3. Aboveground stem					X(L)					
B. Resists as adults					X(L)					
II. Seedling regeneration										
A. Onsite seed										
1. Airborne dispersal										
a. Short viability			X							
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X(?)		X	X		X(?)	X(?)	X	X(?)
b. Long viability						X				
B. Offsite dispersal										
1. Airborne dispersal										
a. Short viability			X		X(H)					
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X(?)		X			X(?)	X(?)	X	X(?)
b. Long viability										
III. Shade tolerance										
A. Tolerant		X	X	X	X		X	X		X
B. Intolerant	X					X			X	
IV. Persistance mode										
A. Invaders			X							
B. Evaders						X				
C. Avoiders					X(L)		X			X
D. Resisters					X(L)					
E. Endurers	X	X		X				X	X	

(con.)

Table 1 (Con.)

Attributes	PRVI	PUTR	RHTR	RIBES	ROSA	RUPA	SASC	SHCA	SPBE	VACCI
I. Vegetative regeneration										
A. Resprouters										
1. Root crown	X	X(1)	X	X(L)	X	X(L)	X			
2. Rhizome or underground								X	X	X
3. Aboveground stem										
B. Resists as adults										
II. Seedling regeneration										
A. Onsite seed										
1. Airborne dispersal										
a. Short viability										
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X	X(?)		X(?)			X(?)	X(?)	X
b. Long viability				X(H)		X(H)				
B. Offsite dispersal										
1. Airborne dispersal										
a. Short viability							X			
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X	X(?)		X(?)				X	X
b. Long viability				X(H)		X(H)				
III. Shade tolerance										
A. Tolerant			X		X	X			X	X
B. Intolerant	X	X		X			X	X		
IV. Persistance mode										
A. Invaders							X			
B. Evaders				X		X(H)				
C. Avoiders		X(2)								
D. Resisters										
E. Endurers	X	X(1)	X		X	X(L)		X	X	X

[1](L) Low intensity fire; (H) high intensity fire; (1) sprouting ecotype; (2) nonsprouting ecotype; (?) no indication by literature, but the suspected response.

II. Persistence mode
   A. Seed based, reproducing primarily by diaspores
      1. Invaders - rapidly spreading plants that establish early, with short-lived seed (DI species).
      2. Evaders - species with relatively long-lived seeds that are stored in the soil or canopy (CI, SI, and ST species).
      3. Avoiders - shade-tolerant species that slowly reinvade burned areas; late successional, often with symbiotic relationships and vertical extensions.
   B. Remains because of adaptation to direct fire
      1. Resisters - shade-intolerant species whose adult stages can survive low-severity fires (WI species).
      2. Endurers - resprouting species, shade-intolerant or tolerant, with shallow or deep-buried perennating buds (VI or VT species).

The information available for each species was rated to identify strengths and weaknesses (table 2). The biological information was considered under the categories of reestablishment and physiology. The fire response was broken down into fire tolerance and treatment strategy. Treatment strategy means information obtained from studies where a fire treatment was applied to influence fire effects. A three-level availability rating was developed, with (1) meaning only general information not specific to fire, (2) some information related to fire response, and (3) considerable information useful in planning fire treatments. A rating of 3 does not necessarily mean that more study is not desirable.

The information for each species follows a format to describe the basic biology, fire response, and uses or values. Species are classified into broad life-form groups. The biology section discusses site, both sexual and vegetative reproduction, and seasonal periodic development. The fire response section discusses the species as an increaser or decreaser in relation to fire. A statement on the management implications concludes the description.

Table 2—Fire information status and research needs rating for shrub species

Information	AMAL	ARUV	ARTR	BERE	CELE	CEVE	JUNIP	LIBO	PAMY	PRMA
Biology										
Reestablishment	[1]3	2	3	2	3	3	2	1	2	2
Physiology	2	2	3	2	1	1	2	1	1	2
Fire response										
Fire tolerance	3	2	3	2	3	3	3	2	1	3
Treatment strategy	2	1	3	2	2	3	3	2	1	2

Table 2 (Con.)

Information	PRVI	PUTR	RUTR	RIBES	ROSA	RUPA	SASC	SHCA	SPBE	SYMP	VASE
Biology											
Reestablishment	3	3	1	2	2	3	3	1	3	3	2
Physiology	2	2	1	2	1	2	1	2	1	2	2
Fire response											
Fire tolerance	3	3	1	2	2	3	3	1	3	3	2
Treatment strategy	2	3	2	2	3	3	3	1	2	2	2

[1]1 - only general information available; 2 - some information related to fire response; 3 - considerable information useful in planning fire treatment.

GENERAL SHRUB RESPONSE

Management goals for manipulating shrubs might be to increase availability for wildlife browse or to reduce shrub abundance to favor trees. A strategy to rejuvenate decadent shrub populations would require scheduling the burn during or immediately after the peak of the seasonal trend in root carbohydrate reserves. Root carbohydrate reserves in shrubs are usually highest during dormancy, especially in species that flower in early spring. In general, spring and fall fires increase the shrub component, while the usually more severe summer fires restrict shrub development.

Shrubs most often are top-killed by fire; they may then resprout vigorously from root crowns or underground parts. Basal sprouting is usually stimulated if the shrub crown is completely killed, which is desirable for wildlife browse. Growth hormones from the partially killed shrub crown maintain some apical dominance in the live branches, which will inhibit growth of new basal sprouts. Complete kill of the aerial crown concentrates growth on lower sprouting plant parts. This is often desirable for the production of wildlife browse.

Although not yet well documented, age and vigor are indicators of shrub response to fire. Older, diseased plants in poor condition generally will respond less vigorously and likely die.

Other factors such as competition levels, fuel consumption, and browsing will also influence postburn shrub survival and response. All of these factors compound the difficulty of accurately predicting shrub responses, though some general statements can be made. Shrubs on moist microsites, or extending into moister habitat types, will have a greater chance of surviving and responding to a fire than similar shrub populations stressed on a dry, exposed site. Nevertheless, the potential survival and regrowth on moist locations may be reduced by any remaining live woody vegetation competing for nutrients, light, and water. Moist sites usually tend to have higher fuel loadings, which when burned might increase the mortality level. These same sites may also possess high duff moisture levels, which can result in less duff reduction by fire and in lower shrub mortality. Shrubs resprouting after a fire are usually subjected to increased browsing by wildlife and livestock. Added to the stress of resprouting and reduced carbohydrate levels, intense browsing can result in lower shrub vigor and increased mortality. Healthy resprouting shrub populations usually maintain adequate leaf material for resupplying the root system under "normal" browsing pressure (Armour and others 1984; Kauffman and Martin 1985).

Soil moisture, fireline intensity, and flame residence time have not been found to be significantly correlated with shrub mortality (Armour and others 1984; Clark and others 1982; Kauffman and Martin 1985). Managers frequently consider soil moisture at the time of burning a major concern in predicting postburn vegetation response. Thermal conductivity in soil increases with increasing levels of soil moisture (DeVries 1963). Snow (1980) suggested that the increased heat load transmitted through higher soil moisture levels would contribute to an increased mortality in oaks. But Frandsen and Ryan (1986) have shown that reduced temperatures and heat loads can be expected with either increased duff, or increased duff and increased soil moisture levels under prolonged heating. Their data supported earlier recommendations to burn after rain had dampened both the duff and the soil if you wish to reduce the impact of prolonged heat on the mineral soil (Aufderheide and Morris 1949) and the biological systems established at that level.

The plant species attributes that influence establishment (vegetative and seedling regeneration) and persistence in a stand are summarized (table 1). The most common mode of vegetative propagation is resprouting from a root crown followed by resprouting from a rhizome. Reproduction from seed, from both onsite and offsite sources, often involves seed of short viability. Reproduction depends on seed transport by animals or means other than wind. Most of the shrubs are early seral components that are intolerant to shade. According to Rowe's classification, many species persist in the stand as endurers.

SPECIES DESCRIPTIONS

Amelanchier alnifolia Nutt.

Biology—Saskatoon serviceberry is an erect, deciduous shrub approximately 3 to 13 ft (1 to 4 m) tall (Blauer and others 1975). In Montana it is a common associate shrub species of all three habitat series, *Pinus flexilis*, *Pinus ponderosa*, and *Pseudotsuga menziesii* covered by this report (Pfister and others 1977), and a prominent shrub in most of the habitat types of the *Pinus ponderosa* and *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). Two growth forms have been reported in Montana (Lonner 1973), a dwarf form (less than 5 ft [1.5 m] tall) that grows from rhizomes, and a taller form whose stems were clumped. A geographical separation of these two forms was noted. The maximum age of sampled live populations of this species was 86 years.

Hemmer (1975) described three types of root systems of serviceberry: deep vertical taproots, lateral roots, and combination of the two types. Taprooted specimens were restricted entirely to talus slopes. Considerable portions of the root structure were found to reside in the mineral soil (Bradley 1984).

This species' response to burning is from a root crown, frequently producing multiple stems (Frischknecht and Plummer 1955; Klebenow and others 1976; Lyon and Stickney 1976; Mueggler 1965; Wright 1974). Most sprouts occur immediately below the fire-killed tissue (Bradley 1984).

Phenology of serviceberry indicates that leaf bud burst begins in early May and might extend until late May. Flowering will start in Montana at the end of May and sometimes continue through mid-June. Mature fruit can be found by the end of July or early September (Schmidt and Lotan 1980). Flowering and the presence of ripe fruit is slightly earlier in northern Idaho (Orme and Leege 1980).

Regeneration from seed appears to be minimal. Good berry crops occur at intervals of 3 to 5 years (Blauer and others 1975). Each berry contains from two (Holmgren 1954) to 10 (Hemmer 1975) small seeds, which average from 45,395 (Blauer and others 1975) to 82,000 cleaned seed per pound.

Dissemination is by animals that pass consumed seeds through their digestive tract. Grouse, some songbirds, and bears feed on the fruit (Hemmer 1975). Serviceberry is considered a key grizzly bear food (Madel 1982; Zager and Jonkel 1983). Large clumps of seedlings have been observed germinating from the same point on the ground where seed was cached by rodents. Planted seed has exhibited short viability (Holmgren 1954), and requires cold stratification (Brinkman 1974a; McLean 1967). The species' characteristics of fire resistance and life history place it in the onsite surviving parts "root crown" offsite seed, "other transport" categories.

Fire Response—Fire resistance of this shrub is excellent; it resprouts from surviving root crown tissue after being top-killed (Fischer and Clayton 1983; Frischknecht and Plummer 1955; Klebenow and others 1976; Lyon and Stickney 1976; Mueggler 1965; Wright 1974). Stem density increases the first year following fire (Gordon 1976; Merrill 1982). Merrill (1982) also found that the mean number of twigs, and the current annual growth on burned sites, exceeded nearby controls the first season. Aboveground biomass and mean heights exceeded the controls by the end of the second postburn season. The species classification adaptation to fire is classified as enduring (W).

Use—This is an important wildlife browse species and is considered fair to highly palatable (Blauer and others 1975). Serviceberry stems, especially new shoots, are heavily utilized by deer and elk (Crane and others 1983; Morris and others 1962). Big game browsing pressure may be sufficient in some regions to eliminate any potential increase in biomass after a fire (Arno and others 1985). The foliage is also consumed by livestock after more palatable grasses and forbs have been grazed (Blauer and others 1975; Morris and others 1962). The fruit is considered of high value as a key bear food (Mace and Bissell 1986; Zager 1980).

Arctostaphylos uva-ursi (L.) Sprg.

Biology—Bearberry is a prostrate, mat-forming, evergreen shrub (Hitchcock and Cronquist 1973; Morris and others 1962). The shrub is common to all three habitat type series in western Montana (Pfister and others 1977), and of the *Pinus ponderosa* and *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). Constancy tends to increase in the moister habitat types within these series.

Bearberry has been reported to regenerate variously as a nonsprouter (Lutz 1956) or as a sprouter developing from runners (stolons) on or just below the soil surface (Berndt and Gibbons 1958). Sprouts can also be produced from undamaged root crowns (McLean 1969); however, this appears to be unusual. Rowe (1983) also reports strong sprouting from golfball-sized lignotubers in the mineral soil. Most roots are near the soil surface (Berndt and Gibbons 1958; Bradley 1984), with runners and fibrous roots extending laterally up to 3 ft (0.9 m) beyond the crown (McLean 1969).

In the Northern Rockies, bearberry flowering begins in late May and is finished by the end of June (Schmidt and Lotan 1980). The fruit contains four to 10 strong nutlets (Hitchcock and Cronquist 1973), and ripens by the end of September (Schmidt and Lotan 1980). Seed is disseminated by gravity and transported by wildlife. As many as 58,000 nutlets are contained in 1 pound (USDA 1948). Germination of the seed has been reported to be as high as 50 percent after acid scarification and alternating warm/cold stratification (Berg 1974). On the basal end of each bearberry nutlet, there is a plugged channel which must be dissolved before the seedling can emerge. This plug has been dissolved experimentally by immersion in sulfuric acid. The hard outer shell (endocarp) of manzanita, a member of the same genus, has also been observed to crack after wildfires (Berg 1974). A similar process may aid germination of bearberry. Soil-stored seed has been reported to germinate after Alaskan wildfires (Lutz 1956), but this trait has not been reported elsewhere. Bearberry has been noted, though, as a successful reinvader of burned sites (Arno and others 1985). The species does not resprout, and seedling regeneration depends upon other transport of offsite seed.

Fire Response—Bearberry's fire resistance is low to moderate, the effects depending on fire intensity, duff moisture contents, soil conditions, and plant location (Fischer and Clayton 1983; McLean 1969; Volland and Dell 1981). The plant will be killed by light ground fire when the root crown is injured (McLean 1969). Vegetative reproduction is rare, especially after fires that remove the organic soil layer (Bradley 1984). Based on Rowe's classification, the shrub is an endurer of fires (VI).

Use—Bearberry is not browsed by livestock (Gullion 1964). Deer, elk, and grouse eat the mature fruits (Gullion 1964). The berry is considered an important food source for bears, particularly grizzly bears (Aune and Stivers 1985; Craighead and others 1982; Gullion 1964; Mace and Bissell 1986). The forage value is fair to good for deer and elk, and the plant is consumed as a winter browse (Gullion 1964; Morris and others 1962; Mueggler and Stewart 1980).

Artemisia tridentata Nutt.

Biology—Big sagebrush is considered the most widespread and common shrub in Western North America (McArthur and others 1979). Several subspecies of big sagebrush are generally recognized (Beetle 1960; Beetle and Young 1965; Winward and Tisdale 1977). Mountain big sagebrush (*Artemisia tridentata vaseyana*) is the commonly occurring variety in this region and is the principal subspecies considered. It is a frequent associated species in the *Pinus flexilis* and *Pinus ponderosa* habitat type series in Idaho, but can also be found on the drier *Pseudotsuga menziesii* habitat types there (Steele and others 1981). In Montana, mountain big sagebrush is an associate of the *Pinus flexilis* habitat types, but occurs on only the driest portions of both of the other two series (*Pinus ponderosa* and *Pseudotsuga menziesii*) (Pfister and others 1977).

This is an aromatic, evergreen shrub with an erect growth form. Height varies from 1 to 5 ft (0.3 to 1.5 cm), but usually averages approximately 3 ft (0.9 m). Mountain big sagebrush is a deep-rooted shrub that can extract large amounts of water from the soil (Sturges 1983).

Seedlings regenerate from a small, round achene (Hitchcock and Cronquist 1973). It may take more than 5,500 seeds to weigh a gram (Deitschman and others 1974a; Plummer and others 1968). Although seed production varies considerably, seed is usually so abundant that germination rates have little effect on establishment (Harniss and McDonough 1976). Seed is disseminated by wind and gravity.

In Idaho, mountain big sagebrush has been reported to start blooming as early as July; seed matures from September to October (Hanks and others 1973). This time period may vary with elevation and latitude. The survival classification (Lyon and Stickney 1976) would fit the following groupings: short viability of onsite seed and airborne offsite seed.

Fire Response—Mountain big sagebrush seed has been shown to germinate more readily following a light heat treatment (Chaplin and Winward 1982). Young plants can grow rapidly and reach reproductive maturity in 3 to 5 years. Big sagebrush is killed by fire; burned shrubs do not resprout (Wright and others 1979). Postburn regeneration is restricted to seedling establishment. Seed are neither highly dispersed nor long-lived in the soil. Seed retained in the low canopy are destroyed by fire. As a result the length of time for reestablishment can be dependent on many factors such as the distance downwind from parent plant seed sources, fire intensity on seed dropped to the ground, and the number of surviving adult plants. According to Rowe's system, sagebrush would be categorized as a DRT, an invading species.

Use—Sagebrush is considered an important food source and cover for upland game birds. Seed from the shrubs have been reported to form up to 62 percent of the annual diet of adult sage grouse in Montana (Wallestad and others 1975). Palatability of the shrub for big game and cattle varies widely. Of the three subspecies, mountain big sagebrush is considered the most palatable (Hanks and others 1973; Sheehy and Winward 1976). Powell (1970) reports that palatability is influenced by volatile oil content. These oils can kill rumen microorganisms, decrease the digestibility of forage, and increase plant toxicity. Robust growth forms tend to be avoided by grazing animals. This may be due to larger quantities of oils formed in rapidly growing plants (Cook and others 1954). Palatability is generally considered as very poor for cattle, poor for sheep, poor-good for deer, and poor-fair for elk (Mueggler and Stewart 1980). The shrub can be important winter browse for mule deer, but not necessarily bighorn sheep and elk (Kasworm and others 1984).

Berberis repens Lindl.

Biology—Oregon grape is a low, evergreen shrub with compound leaves and spiny-tipped, hollylike leaflets (Hitchcock and Cronquist 1973; Morris and others 1962). In Montana this shrub may be found as an associate in all three series discussed in this report (Pfister and others 1977). In Idaho it is absent from the *Pinus flexilis* series (Steele and others 1981). In both areas it becomes greater in constancy in the moister habitat types. In both regions the shrub's constancy class can indicate a habitat type phase.

Vegetative growth is initiated from horizontally growing rhizomes (Bradley 1984; Fischer and Clayton 1983), which grow mostly 0.5 to 2 inches (1.5 to 5.0 cm) below the mineral soil (McLean 1969). Portions above the mineral soil are susceptible to fire damage (Bradley 1984). The shrub may or may not have a root crown close to the surface (McLean 1969).

The fruit is a glaucous, blue berry that may have from one to several seeds within (Hitchcock and Cronquist 1973). This berry is consumed by many forms of wildlife, including bears, which may aid in seed dispersal (Angell 1981). Good fruit crops are borne almost annually, and clean seed run 54,000 to 71,000 to the pound (Rudolf 1974). Seeds from this genus ordinarily do not germinate for 2 or more years after planting and require cold stratification to initiate germination (Free 1957). Seed of Oregon grape has maintained viability for 5 years in sealed containers stored in unheated sheds (Plummer and others 1968). Seedling establishment after fire has been reported (Bradley 1984), possibly originating from a short-term seedbank. The fire survival strategy for Oregon grape is through rhizomes (short viability of onsite seed) and other transport of offsite seed.

Phenological studies of Oregon grape in the Northern Rockies indicate that new leaves first develop from the end of April until late May. Flowering starts in early May and may extend to early August. Ripe fruit can be detected from late June until mid-September (Schmidt and Lotan 1980).

Fire Response—Fire resistance appears to vary from moderate to very susceptible (Fischer and Clayton 1983; McLean 1969; Volland and Dell 1981) and depends on fire intensity and degree of duff removal. Severe fires have also been reported as favoring Oregon grape (Wright 1972). In ponderosa pine forests in northern Idaho, Oregon grape was reported to be absent after high-intensity fires, but not harmed by low-intensity fires (Armour and others 1984). Substantial development in terms of increases in density and height have been noted in the second postfire growing season (Gordon 1976).

Under Rowe's (1983) system, Oregon grape would be classified as an endurer (VT).

Use—The shrub provides browse for sheep. Deer will browse it regularly in the fall and winter, even though it is mildly poisonous (Gullion 1964).

Ceanothus velutinus Dougl.

Biology—In Montana, Morris and others (1962) associate evergreen ceanothus with the Douglas-fir and spruce fir zones. The greatest potential for establishing evergreen ceanothus is on south slopes, followed in order by west and east slopes (Noste 1985). In Montana, *Pseudotsuga menziesii* habitat types have more potential for ceanothus than *Abies grandis*, followed by *Abies lasiocarpa* and then *Thuja plicata* habitat types.

Evergreen ceanothus commonly grows in dense clumps or patches that are 2 to 6 ft (0.6 to 1.8 m) tall. Seeds (61,400 to 152,000/lb) (Reed 1974) are long-lived, remaining viable on forest sites for 200 to 300 years (Gratowski 1962), and they require a heat treatment to germinate

Figure 1—Ceanothus seedlings that germinated from stored seed activated by heat from the fire. No ceanothus was present before the burn.

(Dyrness 1973). The species resprouts from the root crown after being burned and is usually intolerant to shade.

Phenology of evergreen ceanothus in western Montana shows leaf bud burst beginning mid-April and extending into early June (Schmidt and Lotan 1980). Flowering starts after mid-May and continues until after mid-June. Fruit ripens from late-June to early August, and seed fall starts in early August.

Seed is disseminated by mechanical expulsion, gravity, and rodents, and the plant reproduces from onsite seeds. When reproduction is by seed, a large increase in an early successional stage can be expected.

Fire Response—The relationship between fire treatment and ceanothus response provides a basis for management (Noste 1985). Arno and others (1985) state that a medium or severe wildfire or broadcast burn on a Douglas-fir/ninebark habitat type with evergreen ceanothus seed in the soil will result in an evergreen ceanothus community. Stickney's (1980) data for larch/Douglas-fir forests of western Montana show 24 percent ceanothus cover in 6 years following a low-severity fire on a west slope, contrasted to 41 percent cover from a severe fire on a south slope. These values probably represent maximum potential for evergreen ceanothus establishment and growth.

Spring burning in seral shrubfields in the Douglas-fir/ninebark habitat type caused ceanothus to exceed its preburn coverage (11.5 percent to 12.7 percent) the first growing season, and nearly double (21.5 percent cover) during the third growing season (Noste 1985). A severe fall burn set evergreen ceanothus cover back to 0.2 percent the first year, but in the third year the cover was about half of the preburn coverage (18.5 and 10.4 percent). The severe fall burn killed 60 percent of the mature plants, and provided seedbed conditions favorable for germination and establishment of ceanothus seedlings.

A burning treatment to exploit stress and increase the probability of mortality of ceanothus plants has been proposed (Martin 1982). The treatment combines preharvest underburn to weaken mature plants and germinate some seed, with a subsequent postharvest burn. Successive fires at relatively short intervals have been shown to retard shrub growth (Gratowski 1962; Isaac 1940).

Plants surviving from root crowns can be expected to decrease a minor amount following wildfire but regrow very quickly (fig. 1). Using Rowe's system, evergreen ceanothus uses the evader (SI) mode of persistence based on long-lived seeds stored in the soil.

Use—Evergreen ceanothus is of special interest to managers because it fixes nitrogen (Jurgensen and others 1979) and competes with tree seedlings (Gratowski and Lauterback 1974). It is an important wildlife browse species that provides a critical winter food resource for deer and elk (Klebenow 1962; Martinka 1976).

Cercocarpus ledifolius Nutt.

Biology—Curlleaf cercocarpus (curlleaf mountain mahogany) is an erect shrub, or sometimes a small tree. It has the potential on some sites of obtaining heights to 23 feet (7 m). The plant has leathery, persistent leaves (Blauer and others 1975; Hitchcock and Cronquist 1973). It is not listed as being associated with the forest habitat type series being evaluated in Montana (Pfister and others 1977), but does occur in all three Idaho series with varying constancy. In the Idaho *Pseudotsuga menziesii* series it can be found in the drier habitat types; one habitat type is named after the species (Steele and others 1981).

The fruit is a plumose, hardened achene (Hitchcock and Cronquist 1973). The plume aids in wind dispersal of the seed over short distances during August and September (Deitschman and others 1974b). Gruell and others (1985) suggest that fire be excluded from these shrub communities if curlleaf cercocarpus is the potential climax, and where stands are less than 50 years of age. They suggest that fire may be useful in stimulating communities of low vigor. Stands that are successional to conifers will depend on periodic fire to maintain the seral condition (Gruell and others 1986).

Fruit size varies considerably by ecotypes. Collections from Utah averaged 51,900 cleaned seed per pound. The seed can be stored dry for at least 5 years or longer. Most seed evidently is dormant and stratification is necessary (Deitschman and others 1974b). Germination was reported as high on mineral soil that was cleaned of litter and plant competition (Phillips 1970a). High seedling mortality, however, can be caused by summer drought and rodents.

For less severe fires, curlleaf cercocarpus can be listed as reproducing by onsite surviving parts-stem sprouts, onsite seed-short viability, offsite seed-airborne. Fires that kill the canopy and consume the immediate seed source create dependence on an offsite seed source.

Fire Response—Curlleaf cercocarpus has a relatively deep, well-developed root system. It is a weak sprouter (Wright and others 1979) and is prone to being damaged by fire. Mortality can be high after severe, high-intensity fires. The lower bark is thick, which aids in survival of low-intensity fires, with sprouts originating from adventitous buds on the stem (Gruell and others 1985). Rowe's life-form classification would categorize the plants as WTC resisters for low-intensity fires. Severe fires can change the status to DT avoiders.

The presence of curlleaf cercocarpus has been related to fire protection by natural landscape features such as rock outcrops. Young stands have invaded deeper soil sites with the improvement of fire suppression techniques and the removal of fuels by livestock (Dealy 1975; Gruell 1983; Gruell and others 1985; Scheldt 1969).

Use—Forage from curlleaf cercocarpus is highly palatable for both elk and mule deer (Mueggler and Stewart 1980; Smith 1952), and is considered a preferred browse (Kufeld and others 1973). It is rated as only fair for cattle and sheep (Mueggler and Stewart 1980). Stands of the shrub also provide cover for big game (Dealy 1971), but can become overutilized and deteriorate (South 1957). Stands with good seedling input, however, can tolerate the heavy use without experiencing excessive damage (Claar 1973).

Juniperus L.

Biology—Common juniper (*Juniperus communis* L.) and creeping juniper (*Juniperus horizontalis* Moenich) are decumbent to prostrate evergreen shrubs (Hitchcock and others 1969), with berrylike fruit borne on female plants. Leaves of the common juniper are needlelike and in threes, while those of creeping juniper are scalelike and in twos (Hitchcock and Cronquist 1973). Common juniper may be found as a frequent associate only in the drier habitat types of the *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). In Montana, common juniper is of varying importance in all three series considered in this report (Pfister and others 1977). Creeping juniper is not listed as an associate in Idaho (Steele and others 1981), but is throughout the *Pinus flexilis* series and the *Pseudotsuga menziesii/Festuca idahoensis* habitat type in Montana (Pfister and others 1977). The two species will be discussed together because of the many similarities, with exceptions noted.

No inclination towards vegetative reproduction has been reported, though cuttings are a common technique for horticultural propagation of the genus (Free 1957). Reproduction is by seed produced in a small "berrylike" cone (Hitchcock and Cronquist 1973). Seed crop production is irregular (Johnsen and Alexander 1974). Fruit mature after growing 1 year on the shrub (Hitchcock and others 1969). The cones are eaten by gray fox, wood rats, pocket mice, robins, and Townsend's solitares (Gullion 1964). Birds have been reported as important disseminators (Fischer and Clayton 1983; Johnsen and Alexander 1974). Warm temperatures, followed by cold stratification, are necessary to produce good germination (Johnsen and Alexander 1974). Fire survival strategy includes only other transport of offsite seed with accidental introduction after fire.

Fire Response—Both juniper species are susceptible to fire (Fischer and Clayton 1983). The species are reintroduced into a burned area after necessary onsite germination requirements are met. The shrubs classify as avoiders of fire, with highly dispersed propagules (DT species).

Use—Common juniper was rated as moderately valuable browse for deer; creeping juniper was rated good to excellent for mule deer (Morris and others 1962). But Mueggler and Stewart (1980) considered creeping juniper as very poor browse for cattle, sheep, and elk, and poor to fair for deer.

Linnaea borealis L.

Biology—Twinflower is a creeping, evergreen, herblike shrub (Hitchcock and Cronquist 1973). In Idaho it is not recorded within the three habitat type series being investigated by this report (Steele and others 1981). Its presence is highly variable in the *Pseudotsuga menziesii* series in Montana. It ranges from no occurrence in some habitat types to 100 percent occurrence in the habitat designated by the species name (Pfister and others 1977).

The shrub has one-seeded, small, dry fruit (Hitchcock and Cronquist 1973). Nothing has been published on germination requirements and viability.

In terms of the survival strategies, twinflower is an offsite seed, other transport species. The root system is a shallow, fibrous network (McLean 1969). Growing points of roots are on or only slightly below the surface of the duff layer (Bradley 1984; Flinn and Wein 1977).

Fire Response—Lutz (1956) cites Sarvas' (1937) finding that twinflower is unable to resprout following fire. Archibold (1978) reported a single occurrence of sprouting. Rowe's classification would place the plant in the T, avoiders category.

Use—No evidence is available about twinflower's use by wildlife.

Pachistima myrsinites Pursh

Biology—Myrtle pachistima is a low, evergreen shrub approximately 8 to 24 in (0.2 to 0.6 cm) in height (Hitchcock and Cronquist 1973). It can be found as an associate in the more moist habitat types of the *Pseudotsuga menziesii* series in Montana (Pfister and others 1977). The shrub is not listed for the three Idaho series (Steele and others 1981).

There is no evidence that the seed produced by the one- to two-seeded fruit capsules is stored in the soil. Nor does there appear to be evidence to suggest any mode of seed dispersal other than by gravity.

Phenology of the shrub indicates that leaf bud burst will occur between early April and early June. Flowering may start between mid-April and early July. Ripening fruit can be discovered from mid-July until early September (Schmidt and Lotan 1980).

Based on the available literature, this shrub can be categorized as an onsite surviving root crown fire response.

Fire Response—A taproot is the principal storage organ of this plant (McLean 1969). Regeneration following fire is by sprouts produced from the root crown. Rowe's classification would establish the shrub as a VT endurer.

Use—Grazing value is fair to good for big game (Morris and others 1962).

Physocarpus malvaceus (Greene) Kuntze

Biology—Ninebark is a deciduous, erect-to-spreading shrub that can vary 1.5 to 6.6 ft (0.5 to 2 m) in height. In Idaho ninebark occurs with varying levels of constancy in the *Pinus ponderosa* and *Pseudotsuga menziesii* habitat type series (Steele and others 1981). In Montana it can be found in the *Pinus flexilis* series (Pfister and others 1977). In regional habitat type classifications the shrub obtains enough importance in the *Pseudotsuga menziesii* series to be designated a specific habitat type.

The fruit produced by ninebark is a several-seeded follicle (Hitchcock and Cronquist 1973), with the seed distributed primarily by gravity. Some movement by wildlife is also likely, but is undocumented. Germination capacity of the seed is low, even after the necessary stratification (Gill and Pogge 1974a).

Phenology for the shrub indicates that leaf bud burst may begin as early as mid-April in Idaho (Orme and Leege 1980), or early May in Montana (Schmidt and Lotan 1980). Flower production begins in late May in Idaho, early June in Montana. Fruit ripens in early August to late September (Schmidt and Lotan 1980).

Following fire, ninebark regenerates from root crown/rhizomes.

Fire Response—The shrub sprouts vigorously following a fire (Wright and Bailey, unpublished paper). Sprouts originate from horizontal rhizomes, of which a high proportion are situated in mineral soil. The greater the proportion buried in the mineral soil, the better the potential for shrub survival and sprout production following a fire (Bradley 1984).

Merrill (1982) found ninebark more abundant on burned sites than on unburned locations. He also found that twig densities increased through the third postfire growing season. Heights on burned and unburned sites were equal by the fourth season, while aboveground biomass at this time was only 64 percent of the untreated areas. Owens (1982) found that the current annual twig production for ninebark increased with a proportional removal by fire of the shrubs canopy.

Rowe's classification would place the shrub as a VI, enduring species.

Use—Wildlife use of the shrub is usually minimal because more palatable shrubs are commonly associated with it. But for at least 3 years following a fire sprouts of ninebark plants are frequently browsed by deer. Importance of ninebark increases on drier sites, and its importance as an available browse is also likely to increase.

Prunus virginiana L.

Biology—Black common chokecherry is an erect shrub up to 32.7 ft (10 m) tall, with deciduous leaves (Booth and Wright 1966; Hitchcock and Cronquist 1973). In Montana chokecherry may be found as a frequent associate in all three habitat type series evaluated in this report (Pfister and others 1977). In Idaho, chokecherry is not found in the *Pinus flexilis* series (Steele and others 1981), but is present in the others.

The primary means of vegetative reproduction is sprouting from a root crown or occasionally from rhizomes (Chadwick and Dalke 1965). Chokecherry is a prolific sprouter (Chadwick and Dalke 1965; Frischknecht and Plummer 1955), with new sprouts susceptible to grazing injury by deer and cattle (Frischknecht and Plummer 1955; Gullion 1964). Chokecherry is typically clumped because of its sprouting capabilities, frequently exceeding 3 ft (0.9 m) in diameter, and may dominate the site (Chadwick and Dalke 1965).

Seed reproduction is accomplished via a 1-seeded drupe (cherry or berrylike) (Hitchcock and Cronquist 1973), with 3,010 to 8,400 cleaned seed per pound (Grisez 1974). The heavy seeds are disseminated by wildlife and gravity. Gallinaceous and passerine birds feed heavily on the ripe fruit (Gullion 1964; Morris and others 1962; Shaw 1974). Mule deer readily consume the cherries when ripe, their stomachs occasionally containing a quart or more and little else (Gullion 1964). Aune and Stivers (1985) indicated that the fruit is an important grizzly bear food on the eastern frontal range of the Northern Rocky Mountains. Deposited seed may germinate the first spring or remain dormant for two or more winters before germinating (Holmgren 1954). Characteristics of the shrub place it in the root crown—short viability of onsite seed—other transport of offsite seed fire survival strategy.

Phenology indicates that this wide-ranging species goes into dormancy between early September and late November, with bud burst occurring in early April through late May (Schmidt and Lotan 1980). Flowering (anthesis) occurs during late May to early June, with fruit ripening in late June to early July (Schmidt and Lotan 1980).

Figure 2—*Prunus virginiana* and other species of shrubs that regenerated vegetatively during two growing seasons following fire.

Fire Response—Chokecherry resprouts if top-killed (Chadwick and Dalke 1965; Fischer and Clayton 1983; Frischnecht and Plummer 1955) or from singed stems (Volland and Dell 1981), making the species resistant to eradication by fire. Cover value is reduced sharply the first year following fire, with some increase the second year (Gordon 1976). Chokecherry is an enduring (VI) species (fig. 2).

Use—Chokecherry is susceptible to grazing pressure, and may be potentially toxic if consumed in large amounts. Palatability is considered poor to fair for cattle and sheep, but good for deer and elk (Mueggler and Stewart 1980). The fruit is of medium value as a fall bear food (Mace and Bissell 1986).

Purshia tridentata (Pursh) D.C.

Biology—Antelope bitterbrush is an intricately branched, long-lived, deciduous shrub with numerous ecotypes. This shrub is an associate throughout all three habitat type series in Montana (Pfister and others 1977) that are considered in this report. It is absent in the *Pinus flexilis* series in Idaho, but present in the other two series (Steele and others 1981).

The different ecotypes can vary in stature from prostrate to erect growth forms (Blauer and others 1975; Giunta and others 1978). The arborescent forms may attain heights up to 12 ft (3.6 m) but average 3 to 6 ft (0.9 to 1.8 m) (Hitchcock and Cronquist 1973). The shrubs develop a meandering, fibrous root system reaching depths of 15 to 19 ft (4.0 to 5.8 m) (Giunta and others 1978; McConnell 1961). This root system is host to symbiotic nitrogen-fixing species of mycorrhiza (Jurgensen and others 1979; Monsen and Christensen 1976).

The creeping or decumbent ecotypes reproduce vegetatively by layering (Blauer and others 1975; Giunta and others 1978). Soil moisture and plant size appear to be key factors associated with stem layering (Nord 1963). Sprouting from a root crown after top removal is a highly variable response. Ecotype variation in shrub height also appears to affect the shrub's ability to resprout. Prostrate forms of bitterbrush sprout more readily than taller growth forms (Driscoll 1963). Degree of plant injury (Blaisdell 1950; Driscoll 1963; Nord 1965), and environmental factors (Driscoll 1963), are other important factors in determining response.

Sprouting occurs from dormant adventitous buds or from a callus of meristematic tissue at or slightly below ground level (Blaisdell and Mueggler 1956; Driscoll 1963). The degree of sprouting is related to the amount of remaining undamaged tissue capable of producing sprouts and has frequently been related to fire severity. The percentage of sprouting plants appears inversely related to fire severity (Blaisdell 1950; Blaisdell 1953; Driscoll 1964; Nord 1959; Phillips 1970b) and the resultant tissue damage in the root crown. Environmental factors such as aspect, texture of the surface soil, and stoniness which might aid a thermal impulse being transferred into the soil and causing tissue damage would be detrimental to sprouting (Driscoll 1963). Soil moisture has been implicated as a factor affecting resprouting (Nord 1965). Bitterbrush rarely sprouts from the point of layering (Driscoll 1963) or lateral roots (Giunta and others 1978) after fire.

Seedling regeneration is accomplished by a one-seeded fruit (achene) (Hitchcock and Cronquist 1973; Giunta and others 1978). The seed is medium sized, with approximately 15,400 cleaned seed per pound (Blauer and others 1975).

Good seed crops appear to be common and can be predicted (Nord 1963, 1965). The fruit drops shortly after reaching maturity (Holmgren 1954; Holmgren and Basile 1959; Hubbard 1965; Nord 1965). The seed is disseminated by gravity, rodents, and birds (Nord 1965). Germination success (Nord 1965) is aided by high soil moisture (Nord 1965), stratification (Holmgren and Basile 1959; Monsen and Christensen 1976; Pearson 1957), soil disturbance (Edgerton and others 1975), and a litter-free site (Christensen and others 1974). As much as 85 percent of bitterbrush seed can be dormant, and stratification is usually necessary. Seed stored for 3 years (Deitschman and others 1974c) has proved viable.

Under natural conditions germination occurs in the winter, with emergence any time from February until late April (Ferguson 1972). Conditions for good regeneration from seed vary regionally, from excellent every 2 to 3 years (Edgerton and others 1975) to rare (Martin and Dell 1978). Competition for moisture with native vegetation causes high seedling mortality the first year (Hubbard 1956; Holmgren 1956; Sanderson 1962).

Rodents cache large quantities of the seed after it falls (Christensen and others 1974; Hubbard 1965; Sherman and Chilcote 1972; West 1968; Wright 1978). Cached seed not consumed has a good chance of germinating. A hot fire in the fall after the seeds have been cached aids germination by eliminating competing vegetation (Biswell 1973; Holmgren and Basile 1959). Bitterbrush seedlings account for much of the regeneration on severe burns (Blaisdell 1950). Seeds remaining above ground would be either destroyed (Biswell 1973) or if heated above 65 °C (176 °F) have reduced viability (Ferguson 1972).

Bitterbrush flowers for 1 to 2 weeks in early spring (Giunta and others 1978). Latitude and elevation are important factors influencing the period between flowering and seed maturity (Blauer and others 1975; Nord 1965). More northerly and higher elevation ecotypes have a later phenology than southerly or low elevation populations or ecotypes. Usually 50 to 75 days elapse between flowering and seed dispersal, but this period is often shorter in northern ecotypes (Giunta and others 1978). Some fruit may ripen in late June (Ferguson 1972), but most ripen from July until September (Blauer and others 1975; Deitschman and others 1974; Ferguson 1972; Hubbard 1965). Ecotypes that resprout are classified as root crown—short viability of onsite seed—other transport of offsite seed fire survival strategy (Lyon and Stickney 1976). Ecotypes unable to resprout are in the short viability classification or in the onsite seed—other transport of offsite seed classification.

Fire Response—Fire resistance of bitterbrush varies by ecotype. Mortality or damage may range from very susceptible to moderately resistant. Plants without resprouting capability must regenerate from animal-dispersed seed. Regaining preburn status is a slow process and depends on soil moisture and competing vegetation.

Burned plants regenerate most often from dormant buds (Blaisdell and Mueggler 1956). Bitterbrush that resprouts grows rapidly (Blaisdell 1953), but still may take 9 to 15 years to reach preburn conditions (Pechanec and others 1954; Wright 1972). Slow recovery may be due in part to heavy use for browse by numerous species of wildlife and domestic cattle (Gullion 1964). Grazing by livestock has been suggested as a technique for reducing competition to bitterbrush (Phillips 1970b). In general, prostrate ecotypes with the capability to layer show a greater tolerance to fire than erect growth forms (Blauer and others 1975).

The ecotype that resprouts is an endurer (VI) group plant, while the ecotype unable to resprout is a member of the avoider group. This shrub ecotype or form of the species provides an interesting contrast; it is essentially not a fire-resistant species, but is fire-dependent for survival (Sherman and Chilcote 1972).

Use—Bitterbrush is considered excellent browse for cattle and sheep. It is recognized as critically important deer browse year around and is heavily utilized by pronghorn antelope during the growing season. Bighorn sheep consume trace amounts, mostly in the spring (Gullion 1964). Elk also browse the plant heavily (Mueggler and Stewart 1980).

Rhus trilobata Nutt.

Biology—Skunkbush sumac is a low, erect shrub up to 6 ft (1.8 m) (Hitchcock and Cronquist 1973). This species is not a prominent member of any specific habitat type series in either western Montana (Pfister and others 1977) or northern Idaho (Steele and others 1981). In Montana it has been observed in the *Pinus ponderosa* series and the drier portions of the *Pseudotsuga menziesii* series. It is listed here because of its occasional importance in these dry habitat types as a wildlife food source.

Skunkbush has the ability to resprout after being top-killed (Dwyer and Pieper 1967) but evidently shows no inclination to reproduce vegetatively in the absence of severe disturbance. The fruit is a reddish-orange, one-seeded drupe (Hitchcock and Cronquist 1973). There are 7,000 to 9,000 fruit per pound and an average of 20,300 cleaned seed per pound (USDA 1948). Germination and seedling establishment are rare in established skunkbush stands in Montana (Martin 1972). Skunkbush seed germinates poorly without pretreatment by scarification, acid, or hot water soaking. These techniques have been found necessary to crack or soften the hard seed coat. No literature is available on the time length of seed viability (Brinkman 1974b). The embryo inside is also dormant and requires a cold stratification. Several species of birds (Gullion 1964) and animals (Brinkman 1974b) eat the fruit and may disseminate the seed. Life history is too poorly understood to reveal a fire survival strategy.

Fire Response—The species has moderate fire resistance. Frequent or intense fires will restrict the species to protected sites or to areas of light fuel loadings, even though vigorous sprouting occurs after fire, presumably from a root crown (Dwyer and Pieper 1967). The absence of fire has allowed seedling establishment on favorable microsites. Comparison of early historical photographs with current site vegetation mosaics has shown an increase of skunkbush in the absence of fire (Gruell 1983). Based on Rowe's classification, the shrub is probably a VT species, and is a fire endurer.

Use—Skunkbush is rated fair to good (Gullion 1964) to very poor (Mueggler and Stewart 1980) as browse for

sheep and cattle. Bighorn sheep have been observed utilizing only trace amounts in the fall (Gullion 1964). Skunkbush is rated fair to good as deer browse; palatability is only fair to poor for elk (Mueggler and Stewart 1980).

Ribes L.

Biology—Four principal species of current or gooseberry occur in the three habitat type series being evaluated: squaw currant (*Ribes cereum* Dougl.); swamp gooseberry (*Ribes lacustre* [Pers.] Poir.); mountain gooseberry (*Ribes montigenum* McClatchie); and sticky currant (*Ribes viscosissimum* Pursh). All four species can be found in the dry forest habitat series of Idaho (Steele and others 1981). *Ribes lacustre* and *Ribes montigenum* have low constancy values in the *Pinus flexilis* and *Pseudotsuga menziesii* series in Montana (Pfister and others 1977). These individual species will be treated as a group in this text because of their similar growth form and habit. Differences will be noted where they occur.

These shrubs are deciduous, may be armed (gooseberries) or unarmed (currants) depending on species, and are generally low in stature. Their fruit is a many-seeded berry (Hitchcock and Cronquist 1973). Stored in sealed containers, seed can remain viable for long periods (Pfister 1974). Dormant seed of this genus is frequently found in seed stored in the forest soil and duff (Quick 1954). Seedlings are frequently present in the immediate postburn vegetation (Morgan and Neuenschwander in press; Quick 1962). Seed germinates in the spring; mineral soil provides the best seedbed (Pfister 1974). Seed is dispersed by gravity or by wildlife (Volland and Dell 1981). Species in this group will resprout from surviving root crowns following light surface fires, or will regenerate from onsite seed of long viability following fires that remove the organic soil.

Fire Response—The root system is a shallow series of roots radiating from a central root crown. New plants may occasionally sprout from the root system, but this is not common. A fire that removes the organic soil layer will likely kill most root systems. Fires that only top-kill the shrub will allow sprouting to occur from the root crown or from the base of the stems (Volland and Dell 1981).

Under Rowe's system, *Ribes* would be classified as a VI species after a light surface fire or SI after a fire that removes the organic soil. The shrub is an invader species.

Use—Grazing value is low for livestock or game (Morris and others 1962). Ribes fruit is considered of low food value for bears (Mace and Bissell 1986).

Rosa L.

Biology—Roses are armed, deciduous, medium-sized shrubs of which there are several taxonomically similar species. The more common taxa include: Arkansas rose (*Rosa arkansana* Porter), baldhip rose (*Rosa gymnocarpa* Nutt.), nootka rose (*Rosa nutkana* Presl.), and Wood's rose (*Rosa woodsii* Lindl.). They are occasional associates in the various habitat types in the *Pinus ponderosa* and *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). None received mention in the similar classification system in Montana (Pfister and others 1977).

They all have similar abilities to resprout from undamaged or buried root crowns (Mueggler 1965), with some ecotypes spreading by root sprouts (Blauer and others 1975). Seed production probably starts in plants that are 2 to 4 years old (Gill and Pogge 1974b). Seeds are produced in hips, which may or may not persist (Morris and others 1962). Each hip contains 15 to 30 achenes; clean seeds average approximately 45,300 per pound (Blauer and others 1975). Rose seed is primarily disseminated by birds and mammals. Passage through the digestive tract may be necessary for germination (Gill and Pogge 1974b; Morris and others 1962; Shaw 1974). Mice, coyotes, and numerous species of birds feed on rose hips. Porcupines, beaver, pronghorn, mule deer, and elk are attracted by the leafy browse (Gullion 1964). Seed dormancy is broken by a warm period followed by cold stratification (Gill and Pogge 1974b). *Rosa gymnocarpa* seed has been reported in the seedbank of northern Idaho forest soil samples. But *Rosa* seedlings did not appear when duff was burned on these sites (Morgan and Neuenschwander in press).

Flowering is from late May until early September (Budd and Campbell 1950), with fruit production in July to mid-August (Gill and Pogge 1974b). The fire survival strategy is root crown—short viability of onsite seed—other transport of offsite seed.

Fire Response—Wild roses are moderately resistant to fire. Although roses can resprout following fire (Mueggler 1965), the shallow root crown is susceptible to injury. Repeated annual spring burns may greatly reduce both cover and frequency (Bailey 1978). Two years following a single fire, cover and volume may increase (Gordon 1976). Merrill (1982) found that for baldhip rose, mean number of stems and twigs and the current annual growth on burned sites exceeded that on nearby control sites the first postburn year. Stem height on the burns exceeded height on the controls by the second year. Aboveground biomass on the burns exceeded that on the controls by the third season.

The fire survival strategy is classified as a tolerant sprouting (VT) endurer.

Use—The grazing value of rose is poor to fair for cattle and good for sheep. The shrubs are used lightly by deer, elk, and pronghorn antelope (Gullion 1964; Morris and others 1962). *Rosa arkansana* is rated fair-good for both deer and elk (Mueggler and Stewart 1980). Forms having few or no prickles will receive the heaviest grazing pressure (Blauer and others 1975). Rose hips are eaten by bears but are considered of low food value (Mace and Bissell 1986).

Rubus parviflorus Nutt.

Biology—Thimbleberry is an erect, unarmed shrub that has for a fruit an aggregation of small drupelets (berry-like) (Hitchcock and Cronquist 1973). This shrub can be in the *Acer glabrum* and *Physocarpus malvaceus* habitat types of the *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). In Montana thimbleberry can be found in many of the moist habitat types of the *Pseudotsuga menziesii* series, but seldom obtains a high constancy or percent canopy coverage (Pfister and others 1977).

Seeds of the genus have commonly been identified in seedbanks (Graber and Thompson 1978; Moore and Wien 1977; Omstead and Curtis 1947; Oosting and Humphreys 1940). Thimbleberry seed has been identified in forest soil and duff samples by Kellman (1970) and Morgan and Neuenschwander (in press). On sites that had been burned to remove forest slash, thimbleberry mainly reestablishes from seedlings (Morgan and Neuenschwander in press). The germination requirements of thimbleberry have not been examined. But in general, raspberries require warm and cold stratification (Brinkman 1974c). Seed germination is enhanced by a sulfuric acid bath (Heit 1967). But under natural conditions, the seed is slow to germinate because of a hard outer coat (endocarp) and a dormant embryo (Brinkman 1974c). Fruit is dispersed by gravity and possibly by wildlife (Morgan and Neuenschwander in press). In terms of fire survival, this shrub is reestablished from surviving root crowns and rhizomes, and onsite seed of long viability (Lyon and Stickney 1976). Both categories indicate a large potential contribution to postfire vegetation.

Fire Response—Thimbleberry has a root system composed of rhizomes. These can sprout and form large clones. Lyon and Stickney (1976) considered surviving rhizomes the principal mode of reestablishment after a fire. No information is available on rooting depth. If the roots are predominantly in the organic soil layer, they could survive a low-intensity surface fire. More intense fires that remove the duff and soil organic matter would destroy the established root systems, but prepare a seedbed for seed banked in the soil. High-intensity fires in northern Idaho brushfields were found to benefit thimbleberry (Hooker and Tisdale 1974), though no mention is made of the observed mode of regeneration.

Rowe's classification would describe the shrub as a VT, or an ST, evading species.

Use—Grazing value is low for livestock and big game; fruit is valuable for forest wildlife (Morris and others 1962).

Salix scouleriana Barratt

Biology—Scouler willow, an important member of the upland site group, belongs to a genus that is difficult to identify to species level. Scouler willow is a robust shrub 6 to 35 ft (1.8 to 10.7 m) tall (Hitchcock and Cronquist 1973) that occurs on dry slopes within the *Pseudotsuga* habitat types in Montana (Pfister and others 1977) and into the more moist *Pinus ponderosa* habitat types in Idaho (Steele and others 1981).

Willow seeds are very small (6,500 per pound), are disseminated by wind or water (Brinkman 1974d), and are characterized by very short seed life and rapid germination (Zasada and Vierick 1975). Scouler willow resprouts from a root crown following fire, and from airborne seed established on severely burned postfire sites such as the Sleeping Child, Neal Canyon, and Sundance Fires (Lyon and Stickney 1976). Scouler willow fits in two fire survival groups: (1) surviving parts (root crowns), and (2) offsite, airborne, short-viability seeds.

Fire Response—In the West Boulder drainage of Montana, willow canopy of 35 ft^2/acre increased more than tenfold the first year following fire, and more than thirtyfold the second year. This response was in a moist-cool aspen-conifer stand, but shows the potential for willow species to respond to fire treatment. In Idaho, also on a wet site, browse availability below 7 ft (2.1 m) was increased from 5 percent to 100 percent by killing the 25-ft (7.6-m) crown and stimulating resprouting (Leege 1968). *Salix scouleriana* crown cover was 10 times greater under little overstory tree canopy than where tree canopy exceeded 55 percent ground cover, so is intolerant of shade (Mueggler 1965). Also on a wet site, Scouler willow percent frequency and cover increased on logged-piled-burned, single-broadcast-burn, and multiple-broadcast-burn treatments (Mueggler 1965).

In Douglas-fir communities, *Salix scouleriana* is greatly enhanced by fire (Wright 1972). Scouler willow is abundant after burning (Leege 1969; Mueggler 1965). *Salix scouleriana* increases in density following fire because root crowns or single plants produce multiple sprouts (Lyon 1966). According to Rowe's system, Scouler willow is an invader (DI) species. The vegetative resprouting response from a root crown suggests that the endurer classification also applies to willow.

Use—Willow generally has very high value for wildlife. Upland sites are heavily used by deer and elk, while streambottom willow is important browse for moose. Upland game birds, especially grouse, feed on willow buds (Morris and others 1962). It is also grazed by sheep and cattle.

Shepherdia canadensis (L.) Nutt.

Biology—Russet buffaloberry (Canadian buffaloberry) is an erect, 3- to 12-ft (0.9- to 3.6-m) tall, deciduous-understory shrub (Hitchcock and Cronquist 1973; Morris and others 1962). It is an occasional associate in all three habitat type series considered by this report from both Idaho (Steele and others 1981) and Montana (Pfister and others 1977). Buffaloberry sprouts from surviving root crowns and from dormant buds located on the taproot (Fischer and Clayton 1983). Buffaloberry is a symbiotic nitrogen-fixing shrub.

Seed production begins at 4 to 6 years of age, with the possibility of good seed crops every year (Thilenius and others 1974). The small, hard seed shows poor, highly erratic, or delayed germination. Rowe (1983) refers to the species germination response as seed-banking. Cold stratification for a minimum of 60 days appears to be a requirement for embryo development (McLean 1967; Thilenius and others 1974). The fruit is eaten by birds (Gullion 1964; Morris and others 1962) and grizzly bears (Aune and Stivers 1985; Craighead and others 1982; Madel 1982), with dissemination likely by these animals and by gravity.

Leaf buds break dormancy from early April through late June, but usually start by mid-May (Schmidt and Lotan 1980; Thilenius and others 1974). Buffaloberry leaves will normally be retained until early or mid-October, but may drop as early as late August (Schmidt and Lotan 1980). Fire survival strategy may be classified as root crown—short viability of onsite seed—other transport of offsite seed.

Fire Response—This shrub is normally resistant to fire (McLean 1969), but can be eliminated by the treatment (Stickney 1980). As a result it is labeled as moderately resistant to burning (Fischer and Clayton 1983). This species persists in a stand as an enduring species (VT) (Rowe 1983).

Use—Buffaloberry rates very poor as a food source for domestic grazers. It is considered to be good browse for both deer and elk year around (Gullion 1964). The fruit is of high value to bears (Mace and Bissell 1986; Zager 1980).

Spiraea betulifolia (Pall.)

Biology—White spiraea is a low, 1- to 3-ft (0.3- to 0.9-m) (Shaw 1974), erect, clonal, deciduous shrub (Morris and others 1962). This shrub is found in all three forest habitat type series of Montana (Pfister and others 1977) that were evaluated by this study. In Idaho it can be found in the *Pinus ponderosa* and *Pseudotsuga menziesii* series (Steele and others 1981).

This species has the capability to resprout from horizontal rhizomes (Bradley 1984; Fischer and Clayton 1983; Lyon and Stickney 1976; Tiedemann and Klock 1976). New sprouts originate immediately behind the fire-killed tissue (Bradley 1984). Most fibrous roots and rhizomes are located below the mineral soil surface. Roots from below the mineral soil surface are able to produce sprouts (Bradley 1984; McLean 1969) (fig. 3).

Small spiraea seeds borne in a follicle (Stickney 1974) germinate at low temperatures (McLean 1967). The literature revealed nothing on modes of dissemination. White spiraea seed has been recovered from forest soil and duff samples in northern Idaho. Seedlings were not a postfire response; therefore it was speculated seed was of low viability (Morgan and Neuenschwander in press). The fire survival strategy is root crown/rhizome—onsite seed of short viability.

Spiraea is normally in bud burst in early May, but on occasion may be as early as mid-April (Schmidt and Lotan 1980). Flowering has been observed from late May until the end of August, but usually is complete by the end of July. Depending on the time of flowering, the fruit may ripen from late June to early September. Leaves are shed from early September, or early October.

Fire Response—Spiraea is highly resistant to removal by a fire treatment (Fischer and Clayton 1983). The potential to sprout in profusion after fire has been observed, particularly on west aspects (Tiedemann and Klock 1976). In the Selway-Bitterroot Wilderness, ID, Merrill (1982) found that white spiraea on burned sites had greater mean number of stems, aboveground biomass, current annual growth, and mean heights than unburned controls the first postburn season. These values stayed consistently higher for the 4-year length of his study. Normally, the species is slow to recover on drier sites, with only a few initial sprouts. This could be considered a moderate fire response (Volland and Dell 1981). This species resists fire in a stand as an enduring (VI) species.

Use—Browse value of spiraea is low for livestock, and low rating probably is true for wildlife utilization as well (Morris and others 1962).

Symphoricarpos albus (L.) Blake; *Symphoricarpos oreophilus* Gray

Biology—Two species of snowberry occur in this region: *Symphoricarpos albus* (L.) Blake (common snowberry) and *Symphoricarpos oreophilus* Gray (western snowberry). Both species are similar in lifeform and response to fire

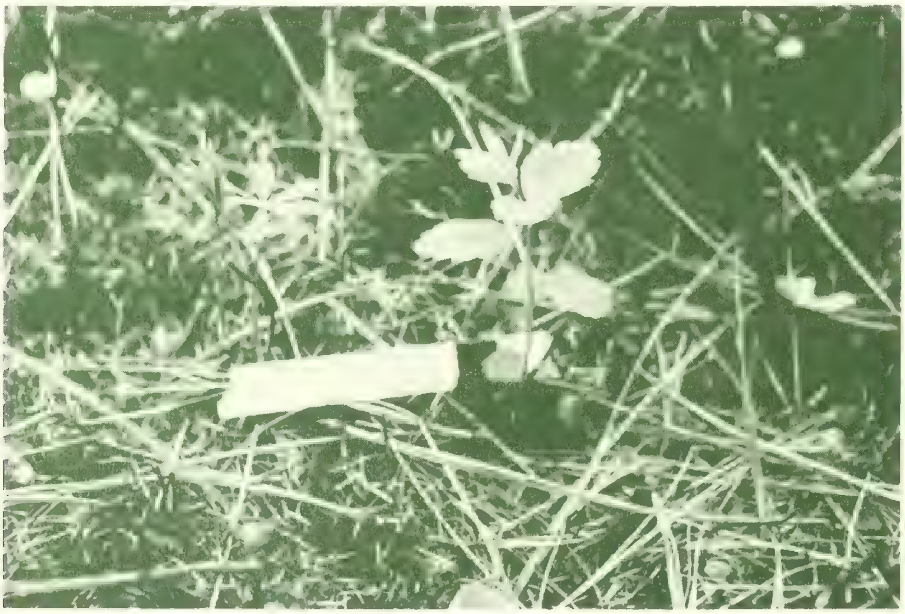

Figure 3—*Spiraea betulifolia* resprouting from a rhizome below the soil surface.

and are combined here for the ease of discussion. Little research has been done with *Symphoricarpos oreophilus*. Most of the text in this section, unless specified as *Symphoricarpos oreophilus*, is from studies on *Symphoricarpos albus*. Snowberry is a low, usually 3- to 6-ft (0.9- to 1.8-m), erect, deciduous shrub (Hitchcock and Cronquist 1973; Morris and others 1962). *Symphoricarpos albus*, however, does not occur in the Idaho *Pinus flexilis* series and is of low constancy in the *Pinus ponderosa* series. In the series dominated by *Pseudotsuga menziesii*, it is of scattered and variable importance (Steele and others 1981). *Symphoricarpos oreophilis* is not a common species in Montana and fails to appear on the habitat type constancy listing for that State. The other species does occur, with highly variable constancy in all three series (Pfister and others 1977).

Common snowberry is clonal, spreading by horizontal rhizomes (Bradley 1984; Lyon and Stickney 1976; McLean 1969; Pelton 1953). The rhizomes are most commonly found 2 to 5 inches (5 to 13 cm) below the mineral soil surface (McLean 1969). Bradley (1984) found averages of 59 percent and 81 percent of the rhizomes below the mineral soil surface on two sites in western Montana. A single aboveground stem may emerge from a rhizome that has grown some distance from the original root mass (Bradley 1984). These aerial stems and their associated rhizome may become independent of the parent system after the first growing season (Pelton 1953).

Sexual reproduction of common snowberry is by two seedlike nutlets per drupe (Hitchcock and Cronquist 1973; Pelton 1953). Seed crop frequency is normally good (Evans 1974). Fruit production increases with increasing stem diameter and to a minor degree stem age. The nutlets are capable of remaining dormant on the shrubs for up to 4 years, though normally the fruit will drop by the second spring or summer (Pelton 1953). Approximately half of the mature nutlets are defective (Pelton 1953), with 54,000 to 113,000 cleaned nutlets per pound (Evans 1974).

Dissemination of the common snowberry nutlets is by rodents, birds and mammals (Evans 1974; Pelton 1953), with many wildlife species utilizing the shrub as a food source (Gullion 1964). Dry fruits float and may be transported during flooding (Pelton 1953). Warm, then cold stratification is necessary (Evans 1974), with optimum germination on a moist media, at 0 to 10 °C temperatures (Pelton 1953). Only 1 percent of nutlets collected in the top 0.8 inch (2 cm) of soil were viable (Pelton 1953), but the species is listed as being seed-banking (Rowe 1983). Snowberry was found in the seedbank of forest sites from northern Idaho, but seed contributed little in postburn vegetation response. It was speculated the seed had low viability, and that seedbanks did not contribute to the postfire regeneration of this (*S. albus*) species (Morgan and Neuenschwander in press). Snowberry, a general increaser, survives fires by means of rhizomes, onsite seed of short viability, and other transport of offsite seed (Lyon and Stickney 1976).

Studies of shrub phenology indicate an early bud burst (Pelton 1953) between mid-April and late May. Flowering is delayed until early June to late August. The fruit is ripe by early September to early October. Leaf fall is usually completed during fruit ripening (Schmidt and Lotan 1980).

Fire Response—Fire resistance of this species is very high in the Intermountain West (Fischer and Clayton 1983). Regrowth after burning occurs from surviving rhizomes (Bradley 1984), even after severe fires (Lyon and Stickney 1976; McLean 1969). Vegetative response following burning is highly variable as reported in the literature. First postburn season stem density may be slightly lower than preburn (Pelton 1953); the same (Gordon 1976); or greater (Merrill 1982). Sprout height has been reported to be half to three-quarters of the preburn stem (Gordon 1976; Merrill 1982; Pelton 1953). Height increases with subsequent growing seasons (Gordon 1976) until finally equaling preburn height by the fourth year (Merrill 1982). But cover and volume measurements consistently exceed original preburn values the second year (Gordon 1976), as does biomass (Merrill 1982). Annual or very frequent fires may be detrimental (Pelton 1953). Rowe's classification suggests a fire adaptation classification as an endurer (VT) of fire.

Use—Snowberry is considered poor to fair browse for cattle, fair to good for sheep, and of no value for horses (Gullion 1964). It is heavily utilized by domestic livestock on overgrazed ranges (Morris and others 1962). Deer use is moderate to heavy, primarily in the summer and fall. Value as forage for elk is fair, and bighorn sheep consume it regularly in the summer (Gullion 1964).

Vaccinium L.

Biology—Huckleberries are usually low, 4- to 12-inch (0.1- to 0.3-cm), creeping rhizomatous to erect shrubs (Hitchcock and Cronquist 1973). Several species are prominent in the habitat type series being evaluated. These include: dwarf huckleberry (*Vaccinium caespitosum* Michx.), globe huckleberry (*Vaccinium globulare* Rydb.), and grouse whortleberry (*Vaccinium scoparium* Leiberg). In Idaho, globe huckleberry and whortleberry are infrequent associates of only the *Pseudotsuga* habitat type series (Steele and others 1981). In Montana globe huckleberry can be found in the *Pinus flexilis* series, as well as joining the other three species in the *Pseudotsuga* series. Constancy and canopy coverage vary considerably with habitat type. Dwarf huckleberry and globe huckleberry are prominent enough on specific sites to be distinguished by habitat types named after the respective species (Pfister and others 1977).

Fruit from the shrubs is a many-seeded berry (Hitchcock and Cronquist 1973). The seeds are not dormant and will start to germinate approximately 1 month after being deposited on a suitable substrate. Some seed will exhibit delayed germination if not subjected to cold temperatures (Crossley 1974). The berries are an important wildlife food, especially for bears (Craighead and others 1982; Madel 1982; Zager and Jonkel 1983). There does not appear to be any evidence that this wildlife use is important to dispersal of the seed. Fire response can be classified for these shrubs as onsite surviving parts by rhizomes, and offsite seed by other transport.

Fire Response—Huckleberries have rhizomatous root systems. Vegetative growth is initiated from the rhizomes and lower stems when the plants are clipped or burned (Miller 1977, 1978). The ability to resprout evidently is not

severely affected by the season of treatment. Miller (1978) attributed this to the onset of seasonal bud dormancy. New sprouts may not bloom until the third growing season, with large berry crops until the fifth or later year (Minore and others 1979). Root systems for several species were found to grow in the mineral soil (Flinn and Wein 1977). Severe fire treatment from both slash and wildfire greatly decreased globe huckleberry for about 15 years before recovery (Arno and others 1985).

This shrub is classified as a VT enduring species.

Use—Dwarf huckleberry has a low grazing value for big game, but the fruit is valuable bird food. Globe huckleberry has a fair value for deer as summer range and is a valuable fruit for bears and birds. Whortleberry is fair to good browse for mountain goats and is possibly fair browse for deer and elk (Morris and others 1962). Whortleberry fruit is also of high value as bear food (Mace and Bissell 1986; Zager 1980).

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GLOSSARY

Achene—A dry indehiscent one-seeded fruit, the seed connected to the pericarp ripening wall of the ovary at only one point (sunflower).

Berry—A fleshy fruit formed from one compound ovary containing few to many seeds (grape).

Clone—Any group of plants derived from a single parental plant by vegetative reproduction.

Deciduous—Woody plants, or pertaining to woody plants, that seasonally lose all of their leaves and become temporarily bare-stemmed.

Decumbent—A stem reclining on the ground but turned upward near the end.

Drupe—A fleshy, indehiscent fruit, usually one-seeded, with a strong endocarp (plum).

Druplet—A small drupe.

Endocarp—The inner third layer of the ripened wall of the mature ovary in the fruit.

Evergreen—Plants, or pertaining to plants, that remain green the year around, either by retaining at least some of their leaves at all times, or by having green stems that carry on the principal photosynthetic function.

Follicle—A dry, one-celled, one-carpellate fruit split down one side (milkweed).

Hip—An aggregation of achenes surrounded by an urn-shaped receptacle (rose).

Nut—A dry, indehiscent, one-seeded fruit, with a hard coat.

Nutlet—A small nut; a very thick-walled achene.

Prostrate—A stem lying flat on the ground, often rooting at the nodes but otherwise not particularly differentiated.

Rhizome—A stem, generally modified (particularly for storing food), that grows along but below the surface of the ground and produces adventitious roots, scale leaves, and suckers irregularly along its length, not just at nodes.

Runner—A very slender stolon, sometimes limited to those which root only at the apex.

Shrub—A woody perennial plant differing from a tree by its low stature and by generally producing several basal stems instead of a single bole, and from a perennial herb by its persistent and woody stem(s).

Stolon—A specialized horizontal stem that trails on the ground and that forms new roots and shoots at its nodes.

Taproot—A thick, tapering root (carrot).

Tuber—An enlarged underground stem, usually rich in starch, and with many buds capable of vegetative reproduction of the plant (potato).

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This paper contains information from diverse sources on the regeneration capabilities, response to fire, and utilization of shrub species important or common to dry forest habitat types in Montana and Idaho. Response to fire is classified by reproductive strategies and how the species persists in the stand. Utility of the species for browsing by livestock and wildlife is included.

KEYWORDS: plants, autecology, regeneration, seed, root-crown, rhizome, wildlife, forage browse, plant survival

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Climate of the Frank Church-River of No Return Wilderness, Central Idaho

Arnold I. Finklin

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Intermountain Research Station
324 25th Street
Ogden, UT 84401

THE AUTHOR

ARNOLD I. FINKLIN was a meteorologist with the Intermountain Station's Fire Sciences Laboratory, Missoula, MT, from 1967 until his retirement from the Forest Service in 1987. His work assignments were with fire use and effects research and, earlier, with lightning research. Specializing in climatology, he holds a master's degree in atmospheric science from Colorado State University.

RESEARCH SUMMARY

This report describes the climate of the Frank Church-River of No Return Wilderness and its vicinity, in central Idaho. This wilderness is the largest designated wilderness in the United States National Forest System. The report, with its numerous tables and graphs, is aimed toward providing information for fire management planning, other wildland management activities, and related research needs. Data have been collected and analyzed from past and present year-round climatological stations, fire-weather stations, storage precipitation gauges, snow-survey courses, and streamflow gauges. These cover varying periods of record, but averages have been adjusted where necessary to standard reference or "normal" periods.

The results show some of the elevational and other topographic effects on climate in this area of complex, rugged terrain. These effects are superimposed upon the larger scale climate, which is characterized by a Pacific-influenced moist (or snowy) wintertime regime and dry July-August summer conditions. Heaviest precipitation occurs in western portions of the wilderness, averaging 60 inches per year in some mountain locations; "rain shadow" canyon bottoms may average only 15 inches.

Afternoon temperatures observed during December-January in lower canyon areas (near 2,500 to 4,000 ft) average close to those in higher western valleys (at 5,000-6,000 ft), indicating frequent day-long inversion conditions. Summer afternoon temperatures show a definite decrease with elevation, at an overall rate of 4.0 °F per 1,000 ft. July-August midafternoon relative humidity averages about 20 to 25 percent in the lower canyons, together with temperatures near 90 °F. The corresponding daily minimum temperatures average about 40 °F lower and, due to the frequent nighttime inversions, are similar to those at adjacent lookouts 4,000 to 5,000 ft higher in elevation. Minimum temperatures of 28 °F or lower ("killing frost") can occur on any date during the summer in some higher basinlike canyon or valley locations.

Climatic trends and fluctuations are examined, using annual and seasonal mean temperatures and precipitation totals. Though short-term fluctuations may be large, little overall trend is indicated in annual precipitation since about 1940, following a recovery from the dry 1930's. July-August precipitation, in percentage of normal, averaged exceptionally high in a recent 10-year period. Fire-weather statistics of afternoon temperature and relative humidity, if based on recent summers (1974-83), give a cooler and more moist picture than that of the longer term.

CONTENTS

Climate of the Frank Church-River of No Return Wilderness, Central Idaho

Arnold I. Finklin

INTRODUCTION

The relatively new policies of wilderness fire management (Fischer 1984), which seek to reestablish the natural ecological role of lightning-caused fire, find a large arena in the Frank Church-River of No Return Wilderness. This wilderness, in central Idaho, is the largest designated wilderness in the United States National Forest System.

This report describes the River of No Return area's weather and climate. These variables are among the important considerations in fire management planning—and in the broader realm of wildland management. The report also provides data for related research needs. The focus is on climate, which, in a statistical sense, integrates the day-to-day weather and its variations. A primary application of climatic data is in the seasonal use of prescribed fire. In addition, the data form a baseline of "normals" for studies of postfire vegetal response and other fire effects. Deviations from normal climatic conditions can greatly influence these effects. Outside of fire-related interests, climatic data may find uses in wildlife management, watershed protection, and recreational planning. In adjacent nonwilderness forest lands, the applications list also includes tree regeneration and insect and disease control.

Previous climatic references or general statements concerning the Frank Church-River of No Return area are cited by Wildesen (1982); Steele and others (1981); Patten and Oliver (1986). A more detailed climatic description has been given for the Selway-Bitterroot Wilderness (SBW), immediately to the north (Finklin 1983a). The present report follows the general scope of the SBW publication, in presenting many up-to-date, original maps, graphs, and tables portraying fire-season and year-round climatic patterns. Ten-day averages and frequency distributions are included. Detailed summary tables and station data listings are given in an appendix. Except as noted, the statistical values are those from our own calculations. All tables are numbered in order of their page appearance, whether in the main text or the appendix.

In discussing the climatic elements over the course of a year, this report will mostly follow the format of treating the elements individually (rather than combining them into a season-by-season account). A condensed climatic summary precedes the main text. The report does not include related or derived factors such as fuel moisture and fire-danger indexes. Because our objective is to present climatic information, detailed physical or technical explanations have been left to references.

For uniformity, all times given in this report are in mountain standard time (m.s.t.) and are expressed in 24-hour clock (or "military") time. A northern portion of the wilderness, north of the main Salmon River, is actually in the Pacific time zone. For conversion to daylight savings time, 1 hour is added to these times.

DESCRIPTION OF THE AREA

Established by Congress in 1980, the Frank Church-River of No Return Wilderness, hereafter abbreviated as the "RNR" or "the wilderness," occupies an area of about 2,370,000 acres in central Idaho (fig. 1). This area is the largest of any designated National Forest System Wilderness in the United States, slightly surpassing that of the Misty Fiords Wilderness in Alaska. The RNR is nearly twice the size of the adjoining Selway-Bitterroot Wilderness to the north, which was the largest wilderness in the lower 48 States prior to 1980. The RNR covers portions of six National Forests—the Bitterroot and Nez Perce in the Forest Service's Northern Region and the Boise, Challis, Payette, and Salmon in the Intermountain Region.

The terrain is notably rugged, except for a northern plateau area. Most of the RNR lies within the Northern Rocky Mountain physiographic province (Steele and others 1981; Wildesen 1982), a complex of mountains dissected by deep, narrow canyons. The underlying rocks are largely granites of the Idaho batholith. The primary drainage within the Wilderness is that of the Middle Fork Salmon River, flowing generally northeastward to northward from near the southern boundary. The main Salmon River, flowing generally westward, cuts through the northern RNR and forms the northern wilderness boundary in the extreme east and west. Wilderness elevations range from about 2,000 ft above sea level in the extreme northwest along the main Salmon River to 9,000 to 10,000 ft on many peaks, reaching 10,340 ft atop Twin Peaks on the southeastern boundary.

The distribution of forest trees and their habitat types is, of course, governed largely by elevation and aspect, and the related climatic conditions. Details are given by Steele and others (1981), Wildesen (1982), and Patten and Oliver (1986). Generally and simply, potential climax tree species range from whitebark pine (*Pinus albicaulis*) and subalpine fir (*Abies lasiocarpa*) at relatively high elevations; to lodgepole pine (*Pinus contorta*), grand fir (*Abies grandis*), and Engelmann spruce (*Picea engelmannii*) at intermediate elevations; to Douglas-fir (*Pseudotsuga*

Figure 1—Location of Frank Church-River of No Return Wilderness.

menziesii) and ponderosa pine (*Pinus ponderosa*) at relatively low elevations—above the grassland and shrub zone of the lower canyon bottoms. Because of fire, however, these and other trees occur over a broader elevational range as seral species, together with their diverse undergrowth communities.

The entire RNR had an annual average of 75 lightning fires and 10 person-caused fires during the period 1960-83 (Patten and Oliver 1986). These averages include only two Class C fires (10 acres or larger) and one Class D fire (100 acres or larger). Considering eight geographic fire areas, most of the larger fires occurred in the main Salmon River corridor and the Middle Fork Salmon River corridor. The effect of fire suppression since 1935 was strongly evident in a comparison with historic fire occurrence inferred from a Salmon River Breaks study area (Barrett 1984).

STATIONS, DATA, AND METHODS

Station locations providing data for this report are shown in figure 2. An alphabetical listing of stations, with additional details, is given in table 11 (appendix). The stations, past and present, represent about 110 separate locations within or adjacent to the Frank Church-River of No Return Wilderness, westward to the Snake River. The term "RNR area," when used in our text, thus includes the wilderness and its vicinity.

The stations are of two main types: (1) the year-round climatological substations of the National Weather Service (formerly U.S. Weather Bureau) and (2) the seasonal fire-weather stations operated by the Forest Service. This report utilizes data from 29 year-round stations, 20 of these active in 1985, and 42 fire-weather stations (seven of these at year-round station sites), including 17 lookouts.

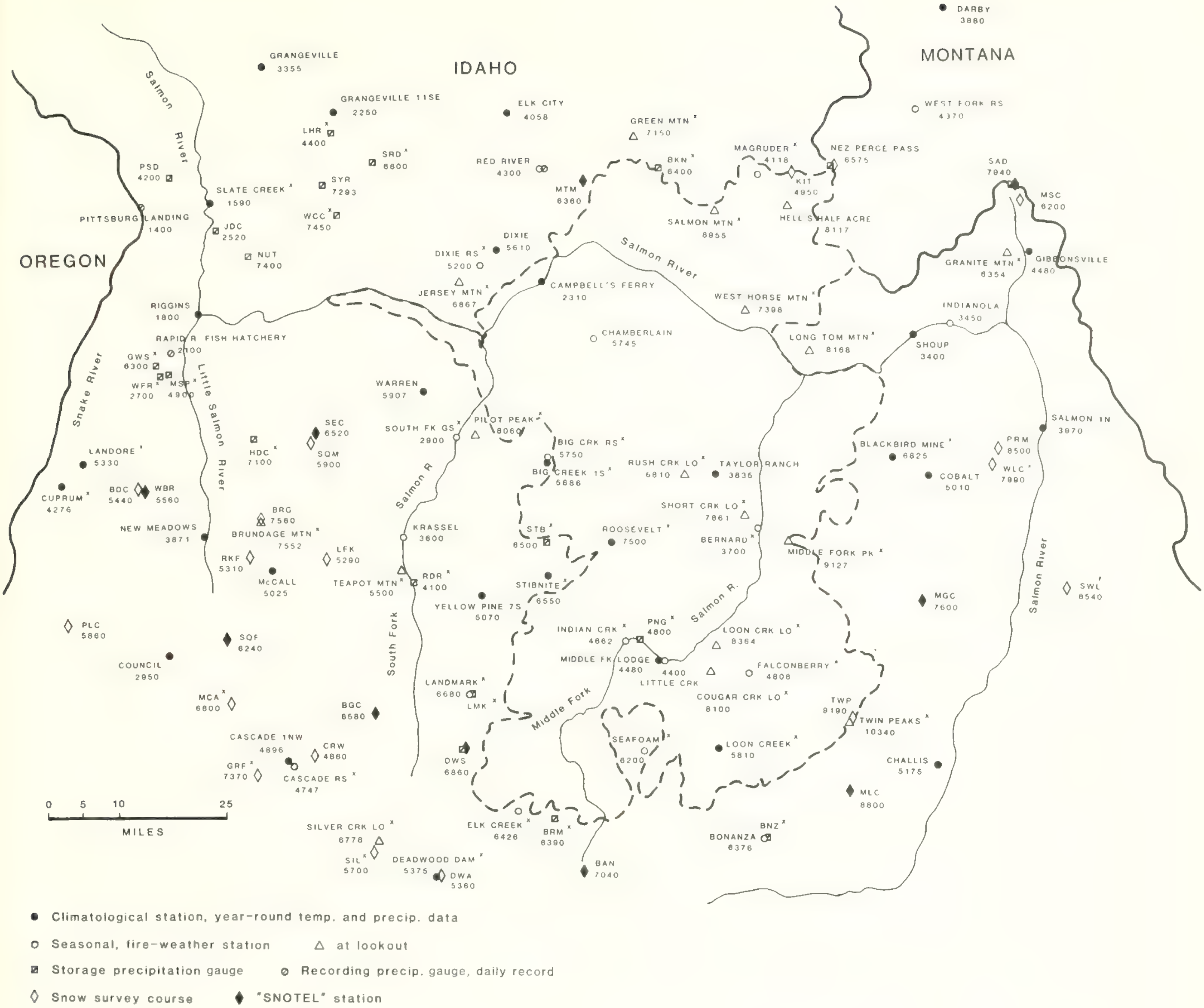

Figure 2—Locations of stations used in this report; symbols indicate type of station. Wilderness boundary shown by heavy dashed line. Numbers are station elevations, in feet. RS denotes Ranger Station; GS, Guard Station; LO, Lookout. Three-letter abbreviations, given for snow course (or SNOTEL) sites and storage precipitation gauges, are identified in table 11 (appendix). Superscript x denotes formerly existing station (closed by 1985).

Only 11 of the fire-weather stations were operating in 1985. The long-term, year-round stations are all outside the wilderness boundary.

Data for the year-round stations, reporting daily maximum and minimum temperatures and precipitation, were obtained and tabulated mostly from publications of the U.S. Weather Bureau and its successor agencies. These publications are U.S. Weather Bureau (1936, 1937, 1958a, 1964), National Oceanic and Atmospheric Administration (1982), and monthly and annual issues of "Climatological Data" State summaries for Idaho. Additional data sources were microfiche copies of original observation forms, available from the National Climatic Center, Asheville, NC, and magnetic tapes from the State Climatologist, Moscow, ID.

Most of the fire-weather data were accessed from the National Fire-Weather Data Library (NFWDL), Fort Collins, CO (Furman and Brink 1975), and from original forms for the Northern Region stations, filed at the Intermountain Fire Sciences Laboratory (IFSL). The NFWDL archives, on magnetic tape, go back only to 1964 for Intermountain Region stations; to 1954 for Northern Region stations. Some earlier data printouts for Intermountain Region stations were found at IFSL—remnants of a past fire-danger study, and data from stations of the 1930's were extracted from annual reports by Hanna (1933, 1935-39). Inquiries and searches elsewhere for additional pre-1964 Intermountain Region data proved futile; boxes containing the original observation forms had apparently been discarded less than 1 year earlier.

Fire-weather observations were for many years taken in mid- or late afternoon—near 1600 (4 p.m.) m.s.t. during the 1950's and 1960's—but have since been moved ahead to 1300 (1 p.m.). This change, conforming to new national standards, occurred in the late 1960's in the Intermountain Region and in 1974 in the Northern Region. The change has adversely affected data consistency and representativeness, as shown later.

This report also includes data from storage precipitation gauges, including those in or near the Gospel Hump Wilderness northwest of the RNR, and snow-survey courses; some of these courses are now SNOTEL (snow telemetry) sites. The storage gauge data, consisting generally of annual measurements, were obtained from "Storage Gage Precipitation Data for the Western United States" (discontinued in 1977) and annual hydrometeorological data summaries issued by the Nez Perce National Forest. Snow-survey data, giving snowpack depth and water content, were obtained from Soil Conservation Service and Idaho Department of Water Resources (ca. 1980) and the Soil Conservation Service's monthly "Water Supply Outlook" for Idaho. The SNOTEL data, giving cumulative precipitation in addition to snowpack water content, were provided by the USDA Soil Conservation Service office in Boise, ID. These data cover only 5 years, commencing in water year (October-September) 1982.

Streamflow or runoff data presented for several drainages were obtained from Water Supply Papers of the USDI Geological Survey (USGS) and from the USGS office in Boise, ID. Sources of additional data are identified within the main text.

Treatment and Analysis of Station Data

The fire-weather and year-round climatic data were checked for errors and missing values. At some stations in the NFWDL files, actually missing days of data were found to contain repeated data from preceding days. Using backup records and comparisons with adjacent stations, highly suspect daily and monthly values were corrected, replaced with estimates, or discarded. Estimates were made for missing precipitation (and snowfall) amounts; also for many missing temperature and humidity values.

Following this cleanup phase, the fire-weather data were summarized by use of computer programs described by Bradshaw and Fischer (1984). The programs were also run for the climatic stations on the previously mentioned tape. Many resulting tables are presented in the appendix of this report.

For the climatic values used in our figures and text, the averages from short and differing periods of station record were adjusted to identical longer term or "normal" periods of record. This adjustment, described by Landsberg (1958) and Finklin (1983b), employs the "difference method" for temperature and relative humidity and the "ratio method" for precipitation. These methods also aided in our estimates for missing data. Generally, data from three to five adjacent stations with observed or previously adjusted normals were used in each adjustment calculation (examples are given in tables 12 and 13, appendix). The use of at least several adjacent stations was found advisable to help reduce or smooth out adjustment errors resulting from data inconsistencies among individual stations. Adjacent stations were often not ideally located for adjustments in the RNR area, and station records are subject to nonhomogeneity (Conrad and Pollak 1962; Finklin 1983b). Nonhomogeneity is commonplace at long-term climatic stations, where changes in location or surroundings and daily observation time can disrupt comparability with earlier data. Changes in station location are documented to about 1955 by the U.S. Weather Bureau (1958b) and are also given in the annual "Climatological Data" State summaries for 1950 through 1972.

The normals for monthly temperatures and precipitation in this report are based on an international-standard 30-year period, which is currently 1951-80. Assuming there is no trend from climatic change or nonhomogeneous data, this period affords a relatively stable baseline, balancing out many of the shorter term variations. Actually, a longer, 50-year period may be desirable for precipitation (World Meteorological Organization 1967) but was not feasible for use here.

Because of the limited data availability for Intermountain Region stations, our afternoon fire-weather averages are based on the 20 years 1964-83. For comparison, 1951-70 averages at several Northern Region stations are also shown. Not ideal, the 1964-83 period contains a mixture of 1600 and 1300 m.s.t. data, explained earlier; this mixture is about equally divided at Northern Region stations. As shown later, the second half of this period, 1974-83, had a relatively moist, unrepresentative summertime (July-August) regime; this was balanced somewhat by drier, warmer conditions during 1964-73.

CONDENSED SUMMARY OF THE CLIMATE

Average annual precipitation (rain and melted snow) within the Frank Church-River of No Return Wilderness ranges from about 15 to 17 inches at eastern and southern canyon bottom locations to 50 to 60 inches or more over some of the western mountain area. The heavier amounts are favored by terrain-enforced uplift of moist airflow, typically from a southwesterly or westerly quarter. Annual amounts are as low as 7 to 10 inches along the Salmon River east of the wilderness. They average near 30 inches at 5,000- to 6,000-ft climatic stations in valleys and canyons outside the western edge.

Snowfall contributes more than 50 percent of the total precipitation at elevations above approximately 5,000 ft. The average annual snowfall ranges from about 40 to 50 inches in the eastern lower canyons to near 200 inches in some of the higher western canyon and valley areas, and perhaps 400 to 500 inches in the wettest mountain areas. The season of continuous snow cover likewise varies greatly. Average seasonal maximum snow depths in the above three areas are about 15 inches, 45 to 55 inches, and 100 inches or more, respectively. The maximum depths are usually reached in January, February-March, and March-April, respectively.

December and January are generally the cloudiest and wettest (snowiest) months within the wilderness. (An ex-

ception is noted in the following paragraph.) These months have precipitation averages of about 1.5 to 2.0 inches in the eastern and southern canyons, near 4.0 inches in the higher western canyons and valleys, and 8.0 to 9.0 inches or more in the wettest mountain areas. The two canyon areas at this time of year receive daily precipitation ⩾0.10 inch on an average of 5 to 6 days and 10 to 11 days, respectively, per month. Sunshine duration in December at wilderness locations is estimated to average only about 25 to 40 percent of the maximum possible.

May and June are normally the wettest months in some lower canyon areas, particularly along the main Salmon River. Elsewhere, these two months present a secondary peak in precipitation or an interruption of a springtime decline. At wet mountain locations, the decline continues but May-June precipitation is still substantial. The May and June monthly averages are mostly 2.0 to 3.0 inches, but are closer to 1.5 inches in southern canyon-bottom areas.

Precipitation normally decreases greatly in July, with monthly averages between 0.6 inch and 1.0 inch over a wide area; a slight increase follows in August. Only slightly higher July-August amounts are indicated at lookout locations. The frequency of daily amounts ⩾0.10 inch averages about 3 days per month. A recent exception to the July-August dryness occurred in 1983, with a 2-month total of 7.0 inches at Middle Fork Lodge.

In line with the precipitation, average cloudiness is at a minimum in July-August. About 15 to 20 days per month may be classified as clear (daytime cloud cover averaging 0 to 3 tenths). Sunshine duration is estimated to average near 75 to 85 percent of the maximum possible.

The main season of lightning (or thunderstorm) activity extends from May to September, with peak occurrence in June, July, and August. Across the wilderness, the average July-August (2-month) storm frequency within a 20-mile radius ranges from about 10 days in the southwest to 16 days in the northeast. About 60 percent of the July-August storms begin during the 6-hour period 1200-1759 m.s.t. Past lightning counts at lookouts indicate a Lightning Activity Level of 5 (as defined in the National Fire-Danger Rating System) in about 15 percent of the storms.

Temperatures normally average lowest in January and highest in July. The January monthly means (arithmetic averages of the daily maximum and minimum values) range from about 22 to 28 °F in the lower canyons, though much higher to the west at Riggins; from 18 to 21 °F in the 5,000- to 6,000-ft canyons and valleys. The July means range from about 67 to 73 °F and 57 to 63 °F, respectively; the overall annual means, 44 to 50 °F and 37 to 41 °F.

The average maximum temperatures are within a generally narrow range in January, about 30 to 35 °F, indicating daytime temperature inversions in the sheltered lower canyons. July average maximums reach the upper 80's to lower 90's in these canyons; the upper 70's to lower 80's at 5,000 to 6,000 ft. The average diurnal temperature ranges are near 40 °F at many locations in July-August, but they are closer to 20 to 25 °F at lookouts and slope locations, above the cool nighttime inversion layers. July-August afternoon temperatures show an overall decrease with elevation, at an average rate of 4.0 °F per 1,000 ft.

Maximum-temperature extremes since 1930 have ranged from about 105 °F to at least 114 °F in the lower canyons; 95 to 100 °F in 5,000- to 6,000-ft canyon and valley areas. Minimum temperatures have reached about −20 to −30 °F and −35 to −50 °F, respectively.

The season between "killing frosts," as defined by minimum temperature occurrences of 28 °F, is practically nonexistent in some of the higher basinlike canyon and valley locations. Elsewhere near 5,000 ft, the season may average more than 100 days (106 days observed at McCall). In the lower canyon bottoms, the average season ranges mostly from about 140 to 180 days.

Relative humidity, tending to vary inversely with temperature, averages highest near dawn and lowest around midafternoon. Average afternoon values are highest in December-January, generally about 65 to 80 percent, depending on location; lowest in July-August, reaching below 25 percent in lower canyon areas and near 40 percent at 8,000-ft lookouts.

A change in fire-weather observation time in the late 1960's or early 1970's, from 1600 to 1300 m.s.t., has resulted in somewhat higher observed humidity than that in midafternoon. This factor, together with a relatively cool, moist summer regime during 1974-83, brought 10-year afternoon humidity averages 5 to 10 percentage units higher than those in preceding 10- and 20-year periods.

The frequency of early afternoon humidity below 15 percent at a lower canyon location holds steady during mid-May through mid-June, at about 6 percent, rises to 30 percent or higher during late July-early August, and returns to 5 percent around late September.

Nighttime relative humidity probably reaches an average of 90 percent or higher by dawn throughout the year at many sheltered canyon and valley locations. Much lower summer nighttime values, averaging near 60 percent, may occur at locations with less nighttime cooling, particularly on exposed ridges and slopes.

The large-scale wind flow, generally from the west or southwest throughout the year, undergoes much modification by local topography. Wind directions in canyon areas are often constrained by the canyon orientation. Directions may reverse from upcanyon during daytime to downcanyon at night.

In the overlying free atmosphere, average windspeeds are generally highest in winter and lowest in summer. Wintertime speeds may average 15 to 20 mi/h on well-exposed peaks. Sheltered canyon and valley areas may have their lowest average speeds in autumn and winter, about 5 mi/h, and highest average speeds in spring or summer.

Midafternoon windspeeds during July-August average generally between 7 and 9 mi/h in the canyons; up to 10 to 13 mi/h at lookout locations. Highest recorded summer afternoon speeds (10-minute averages at observation time), during a 20-year period reached about 25 to 30 mi/h in the canyons; about 30 to 35 mi/h at lookouts. Stronger winds may occur at other times of day and over shorter durations. The winds are generally lighter at night in the canyons and valleys, becoming calm in sheltered locations. Nighttime wind increases may often occur on openly exposed mountaintop terrain.

A statistically significant persistence tendency is shown, in 55 years of data at McCall, between late spring (May-June) and summer (July-August) average maximum temperatures. These temperatures, expressed relative to normal, may indicate the generally clear, dry (or cloudy, moist) character of the 2-month periods. No persistence is shown between monthly or seasonal precipitation totals.

DETAILS OF THE CLIMATE

Climatic Controls; Broad Weather Patterns

Climatic conditions in this central Idaho area, as elsewhere, are governed by a combination of large-scale and small-scale factors. Among the large-scale factors here are latitude, position on the North American continent, prevailing hemispheric wind patterns, and extensive mountain barriers to the west and east. Small-scale or local factors include the topographic setting and position (canyon, slope, or ridge location), as well as vegetation cover (Oke 1978; Schroeder and Buck 1970). Elevation as a factor has both regional and local components.

The average large-scale airflow in the "free atmosphere," at about 10,000 ft and higher, is from a generally westerly (WNW to WSW) direction throughout the year (Finklin 1986). Important day-to-day and year-to-year variations from this pattern lead to the variety of weather and its anomalies that enter into climatic statistics. The main belt of westerlies aloft retreats northward into Canada in summer, and the primary storm tracks are likewise displaced (Schroeder and Buck 1970).

Broadly, the climate of the RNR area has aspects of both a northern Pacific coastal type and a continental type (Blair 1942). The Pacific influence is noted particularly by a late autumn and winter maximum in cloudiness and precipitation over most of the area, though this is further influenced by the mountainous topography. Summer and early autumn are generally sunny and dry, with July and August the peak fire-season months.

Cloudiness and Sunshine

As just indicated, the period November through February is normally the cloudiest time of year in the RNR area; July-September, the clearest. The adjacent National Weather Service (NWS) stations at Missoula, MT, and Lewiston and Boise, ID, have averages of only 3 to 5 clear days per month during the late autumn-winter period (table 1). Clear days are defined by average sunrise-to-sunset cloud cover, of any type, between 0 and 3 tenths. The corresponding frequency of cloudy days, averaging 8 to 10 tenths cloud cover, peaks at 21 to 25 days in December-January.

Past data from the climatic substations (table 1), however, show several more clear days per month and fewer cloudy days. This is found at the wetter, west-side locations at McCall and Deadwood Dam, as well as the drier east-side locations at Challis and Salmon. Some of the difference may arise from classification of days with high, thin (cirrus-type) clouds, through which the sun can shine, but at least part is apparently true (Benedict 1986). The adjacent NWS stations are sometimes covered by a low-lying cloud layer while the sun is shining at higher elevations.

The monthly average number of clear days increases slowly during spring, then rises sharply to about 15 to 20 days in July-August.

The average annual pattern of sunshine occurrence observed at Boise and Missoula (fig. 3) shows seasonal trends generally following those of cloudiness. The sunshine durations, in percentages of the maximum possible,

Table 1—Monthly average number of days, sunrise to sunset, observed as clear (0-3 tenths cloud cover) and cloudy (8-10 tenths cloud cover), RNR vicinity. For indicated periods of record at adjacent airport (AP) stations.[1] Numbers at other locations are based on 1929-48 data adjusted to same period as at Boise, ID, 1940-81, except as noted[2]

Station		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		Numbers of days											
Boise AP	Clear	5	4	6	7	8	12	21	19	17	12	6	5
1940-81	Cloudy	22	17	17	15	12	8	3	5	6	10	17	21
Missoula AP	Clear	3	2	3	4	5	6	16	14	10	7	3	2
1945-81	Cloudy	24	21	22	20	17	15	5	8	12	17	23	25
Challis	Clear	8	7	8	8	8	9	14	14	13	11	9	8
	Cloudy	12	8	8	9	10	9	7	8	7	9	10	11
Deadwood Dam	Clear	8	6	7	8	9	10	17	15	13	11	8	7
	Cloudy	20	18	18	17	16	15	7	9	10	13	17	19
McCall	Clear	9	8	9	11	12	13	20	18	16	13	9	8
	Cloudy	18	14	14	12	11	10	4	6	8	10	15	18
Salmon	Clear	7	6	8	9	10	12	18	17	15	12	8	7
	Cloudy	17	12	12	11	10	7	5	6	7	10	14	16
Loon Creek[3]	Clear	10	9	11	8	8	11	14	13	13	15	12	11
1909-23	Cloudy	15	13	13	14	15	12	8	9	11	9	13	15

[1]Data based on hourly observations; all types of clouds included.
[2]Numbers are not strictly comparable with those at airport stations; may not include high, thin cloudiness. Adjusted with aid of Boise 1929-48 data.
[3]As observed during indicated period.

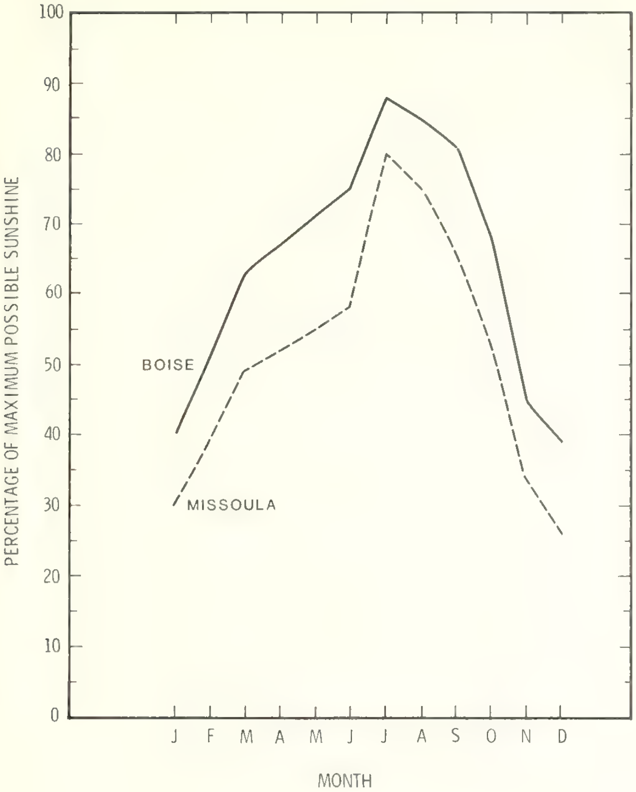

Figure 3—Monthly average precentage of maximum possible sunshine duration, observed at National Weather Service airport stations adjacent to RNR. Based on period 1940-81 at Boise, ID; 1945-81 at Missoula, MT.

are independent of the seasonally changing length of daylight. At 45° N. latitude, this length (sunrise to sunset) varies from 8.8 hours in late December to 15.6 hours in late June. Sunshine durations over the RNR area should lie approximately within the range shown in figure 3, but greater late autumn-winter values are possible over parts of the area—in line with the apparent differences in cloudiness. Summer sunshine durations may be reduced over higher mountain terrain, particularly toward the north and east.

Sunshine at wilderness locations is thus estimated to average mostly between 25 and 40 percent of the maximum possible in December-January; about 75 to 85 percent in July, slightly less in August. The equivalent monthly total hours of sunshine in a hypothetical flat, open location ranges from about 70 to 110 in December to 350 to 400 in July. Maps by the Environmental Science Services Administration (ESSA) (1968) and Baldwin (1973) show lower sunshine duration values.

Incoming solar radiation (insolation)—the solar energy received with sunshine and also through cloud cover—likewise varies considerably with time of year. The ESSA (1968) maps and Bryson and Hare (1974) indicate that average insolation may range from about 110 to 130 langleys (gm-cal/cm^2)/day in December to 630 to 670 langleys/day in July. These values, for measurements by a standard Eppley pyranometer, include both the direct-beam radiation and the diffuse radiation (Reifsnyder and Lull 1965; Schroeder and Buck 1970). The values are those for a horizontal, unobstructed surface. A general increase in solar radiation with elevation (Barry 1981; Geiger 1965), and effects of slope and aspect (Buffo and others 1972; Finklin 1983a), will modify the base values.

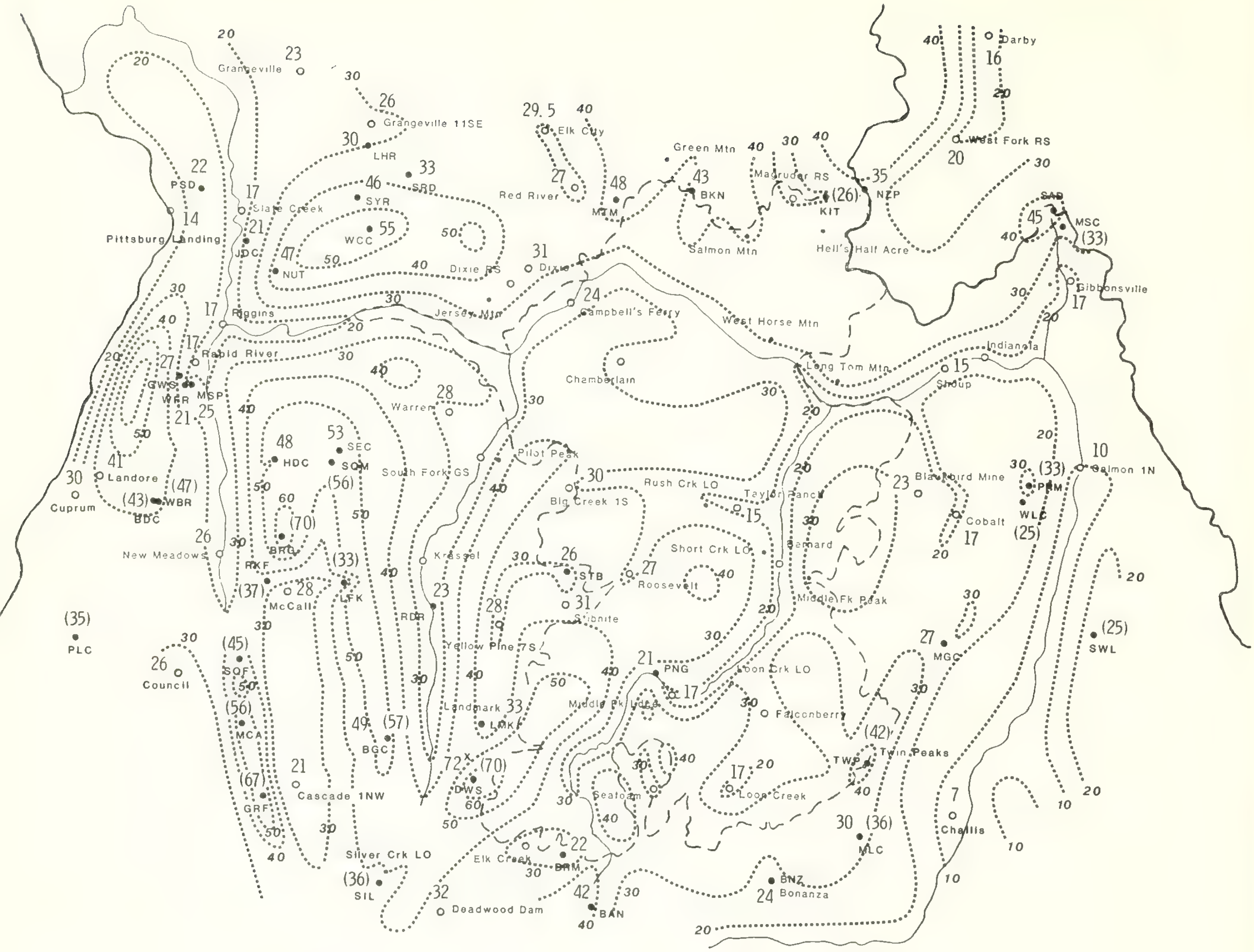

Figure 4—Average annual precipitation, inches, in or near RNR. Based on or adjusted to 1951-80 normal period. Number in parentheses is annual estimate based on snowpack data. Superscript x (at Deadwood Summit) denotes observed 28-year average from former storage gauge, 1948-76; indicated normal at present SNOTEL station (adjusted 1982-86 average) is only about 55 inches. Dashed lines (isohyets), drawn and labeled at 10-inch intervals, are fitted to data and general topography; pattern is smoothed and approximate.

Precipitation; Snowfall

ANNUAL PRECIPITATION

As indicated in figure 4, normal annual precipitation (rain and melted snow) within the RNR boundary ranges from about 15 to 17 inches at eastern and southern canyon-bottom locations, even at a 5,800-ft elevation, to 50 to 60 inches or more over some of the western mountain area. Such high amounts are observed at adjacent storage gauge and SNOTEL stations, which are located near road summits. Amounts average between 28 and 33 inches at the high-valley, 5,000- to 6,000-ft climatic stations outside the western edge of the wilderness. These stations include McCall and Dixie. To the east, averages are down to 7 to 10 inches along the main Salmon River, as at Challis and Salmon. The precipitation lines (isohyets) shown in figure 4 represent only a smoothed, approximate pattern, due to the complex topography and scattering of data points. A more detailed line pattern has been constructed on unpublished map overlays at the University of Idaho, as described by Warnick and others (1981).

The generally heavier precipitation amounts over the western portion are favored by terrain-enforced uplift of moist airflow, typically from a southwesterly or westerly quarter during storms. Drier areas are influenced by descending air motion, both locally, as in deep canyons, and in the lee of the major mountain complex. Considering the entire area mapped in figure 4, there is a low correlation between annual precipitation and elevation. Over separate portions of the area, however, precipitation does generally increase with elevation, with the increase (or downward decrease) noteworthy along some slopes.

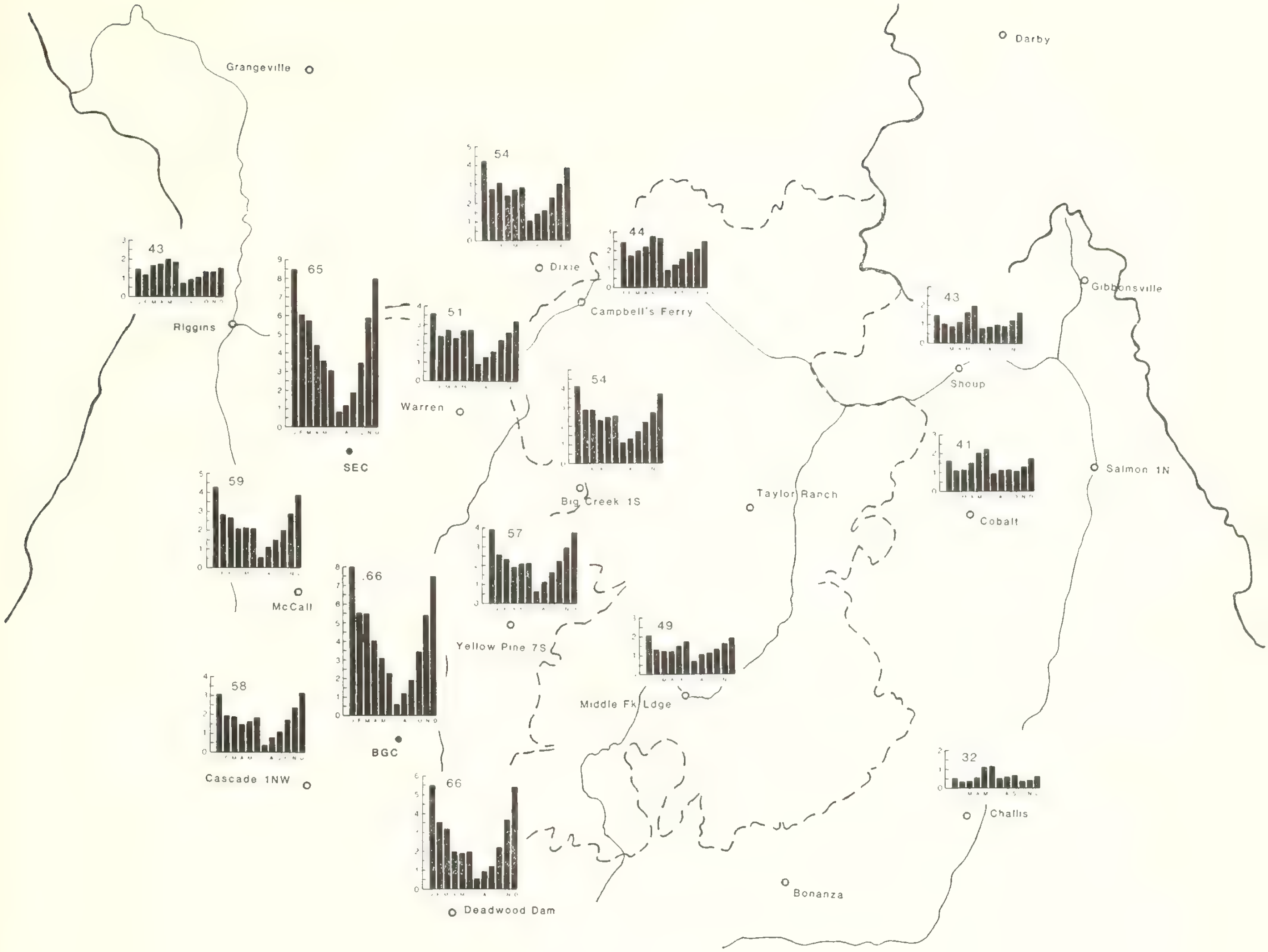

Figure 5—Average monthly precipitation, inches; annual regime. Based on or adjusted to period 1951-80. Numbers above graphs are ratios of 5-month November-March total to annual total.

MONTHLY DISTRIBUTION

In the RNR area, the 5-month period November through March contributes about 65 percent of the annual total precipitation at the wettest locations; 55 to 60 percent at places like Dixie and McCall; near 45 to 50 percent in the canyon bottoms. As detailed in figure 5 and table 14 (appendix), over most of the area January normally has the heaviest monthly precipitation, with December a close second. Exceptions occur mainly in the drier eastern portion, where May and June are normally wettest.

The January averages within the wilderness range from about 1.5 inches to 9.0 inches or more. The high-valley climatic stations to the west receive about 4.0 to 5.0 inches; Challis and Salmon, to the east, 0.6 to 0.8 inch.

Following a decline through early spring, precipitation normally increases or levels off in late spring (May-June) at all but the wettest locations (where the decline continues). May and June monthly averages are mostly 2.0 to 3.0 inches; closer to 1.5 inches in southern canyon bottoms. A large decrease follows in July, normally the driest

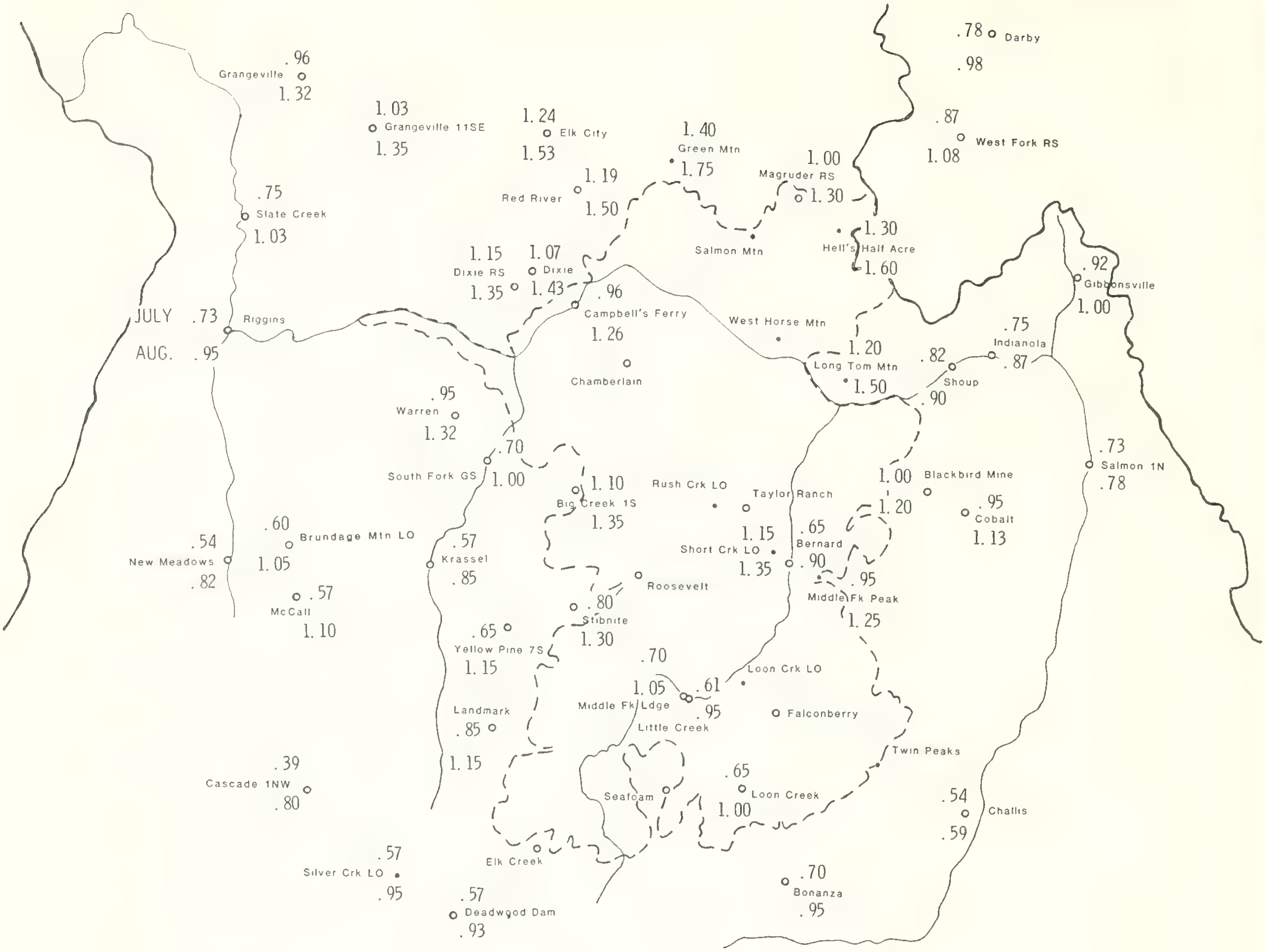

Figure 6—Average precipitation, inches, during July (top number) and August (bottom number). Based on or adjusted to period 1951-80.

month. Portrayed further in figure 6, the July precipitation averages (1951-80 normals) are mostly between 0.6 and 1.0 inch throughout the wilderness canyon and valley areas, with highest amounts near the northern boundary. The August averages show an increase of a few tenths of an inch. Only slightly higher July-August amounts are indicated at lookout locations. A further slight increase generally occurs in September, initiating a more pronounced autumn increase in the wetter areas.

To indicate the year-to-year variations that have occurred at moderately wet locations, table 15 (appendix) lists the monthly precipitation amounts for each year of record at several stations. These stations are McCall, with data continuing from 1917, and Dixie and Deadwood Dam, with 30- to 40-year periods of record.

Monthly and 10-day statistical summaries are given for McCall and seven other stations in table 16 (appendix). The available periods of record are only about 20 years at some of these stations.

ANNUAL AND MONTHLY EXTREMES

As shown in table 15 (appendix), McCall has had observed annual (calendar-year) precipitation ranging from 13.87 inches in 1935 to 36.70 inches in 1982—or from 50 to 131 percent of the present normal of 28 inches. Before its station closure in 1974, the Deadwood Dam locale had a range from 19.42 inches in 1935 to 49.82 inches in 1970, or from 60 to 155 percent of its estimated 32-inch normal. Much drier Challis to the east, with a normal of 7.4 inches, received only 2.62 inches in 1935 and a maximum of 11.25 inches in 1983; the equivalent range is from 36 to 152 percent.

The former standpipe storage gauge at Deadwood Summit, read yearly in July and averaging 72 inches, caught 115 inches in the 1973-74 season. Its 28-year minimum was 51 inches in 1974-75.

Highest monthly precipitation totals at McCall have exceeded 8.0 inches in November, December, and January,

with an extreme of 9.25 inches in November 1973. Deadwood Dam received 16.61 inches in December 1964 and has also had more than 10.0 inches in January and February. The highest observed monthly total at Challis occurred in June, 3.83 inches in 1963, though December 1964 was close behind with 3.72 inches. These stations have had zero or trace precipitation totals during summer months, as in both July and August 1969 at McCall; also during the phenomenally dry September and October 1987, when McCall's 2-month total was 0.01 inch.

DAILY PRECIPITATION

Frequencies of various daily (24-hour) precipitation amounts are shown in table 17 (appendix). The monthly trend of such frequencies for two threshold amounts is depicted in figure 7, combining data from two groupings of stations. The plotted values are roughly those for the current normal period. Measurable precipitation, ⩾0.01 inch, occurs on close to one-half of the December and January days at higher western valley or canyon locations. Here, amounts ⩾0.10 inch occur on about one-third of the December and January days. The monthly frequencies appear well correlated with monthly average precipitation, showing the late spring (May-June) plateau and the sharp decrease in July.

At the drier, lower canyon stations, the corresponding frequencies average 10 to 15 percentage units lower than in the wetter western area during late autumn through early spring. The frequencies for the two station groups become practically identical in the dry summer months. The percentages (fig. 7) indicate precipitation amounts

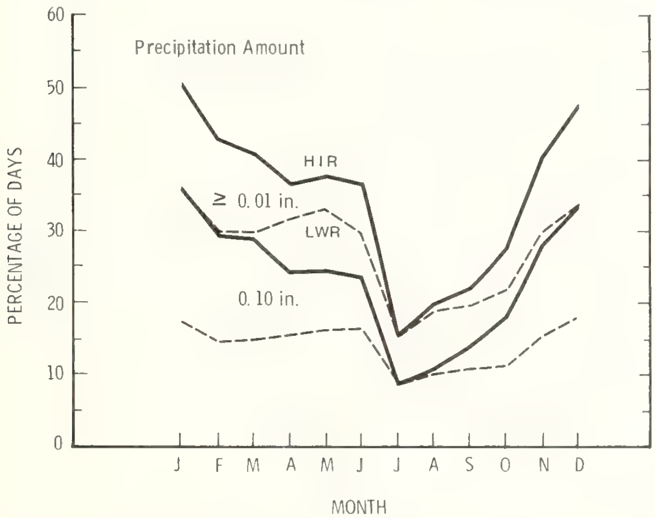

Figure 7—Monthly percentage frequency of days with observed daily (24-hour) precipitation equal to or greater than 0.01 inch and 0.10 inch; averages for two groupings of stations. HIR denotes higher valley or canyon location near west edge of RNR, average annual precipitation about 30.0 inches; data from McCall (1951-81), Big Creek 1 S (1949-67), and Dixie (1962-81). LWR denotes lower canyon location, average annual precipitation about 16.0 inches; data from Riggins (1951-80), Middle Fork Lodge (1971-81), and Shoup (1966-81).

⩾0.01 inch on an average of 5 days during July; amounts ⩾0.10 inch on 2 to 3 days.

Daily precipitation ⩾1.00 inch occurs on an average of generally 2 to 3 days per year at moderately wet locations, such as Dixie and McCall. It occurs on 4 or 5 days at Deadwood Dam (data from Pacific Northwest River Basins Commission 1968). These days are most frequent in winter (table 17, appendix). At drier locations such as Middle Fork Lodge and Riggins, 1.00-inch occurrences average less than once per year.

Extreme daily amounts have reached 2 to 3 inches at some of the available stations, during varying periods of record. The greatest noted, for a fixed 24-hour observational period, is 3.07 inches at Deadwood Dam in December 1941 (above reference). Big Creek recorded 2.62 inches in December 1964; McCall, 1.90 inches in January 1956. Record extremes have occurred at other times of year at some locations, with 2.49 inches at Riggins in July 1978; 2.45 inches at Warren in October 1962; 2.45 inches near Yellow Pine in September 1970. Two-day totals have reached 5.09 inches at Deadwood Dam and 3.42 inches at McCall. Miller and others (1973) estimate 25-year, 24-hour extremes as high as 4.0 inches over part of the western wilderness terrain.

PRECIPITATION DURING THE FIRE SEASON

Some precipitation details covering the official May-October fire season are given in figure 8, using 10-day resolution. The irregularity shown in the graphs has been found by the author for other parts of Idaho and Montana, even with 50 years of data; much is probably an accidental, or random, effect.

The broader features (fig. 8, lower panel) show the normally substantial springtime precipitation, which peaks in early June. At this time, the two-station, Dixie and McCall 10-day average is near 0.95 inch. The ensuing decline in July average precipitation appears to be somewhat abrupt, particularly at such wetter locations. The Dixie-McCall 10-day average decreases about 0.40 inch from June 21-30 to July 1-10. The resulting July amounts in figure 8 are nearly similar to those depicted for the usually drier locations (represented by Riggins-Shoup), though there is a noticeable difference between the individual Dixie and McCall averages (fig. 6). A minimum averaging near 0.20 inch is reached during July 21-31. After a peculiar spike in mid-September, the main, steady autumn increase at the wetter locations begins in early October. Only a slight autumn increase occurs at the drier locations.

Although July-August precipitation is normally light, exceptions have occurred, particularly in more recent years. As extreme examples, the 2-month totals reached 7.01 inches at Middle Fork Lodge in 1983; 6.60 inches at Yellow Pine (7 S) in 1983; 5.68 inches at McCall in 1976; 5.66 inches at Riggins in 1978.

Frequencies of selected precipitation amounts (fig. 8, upper panel) follow the same general pattern as the 10-day average precipitation. These frequencies, and the averages, may give only an approximation of probable values for future periods of years. With this qualification, the chance of 24-hour precipitation ⩾0.10 inch holds rather steady during April through early June, averaging about

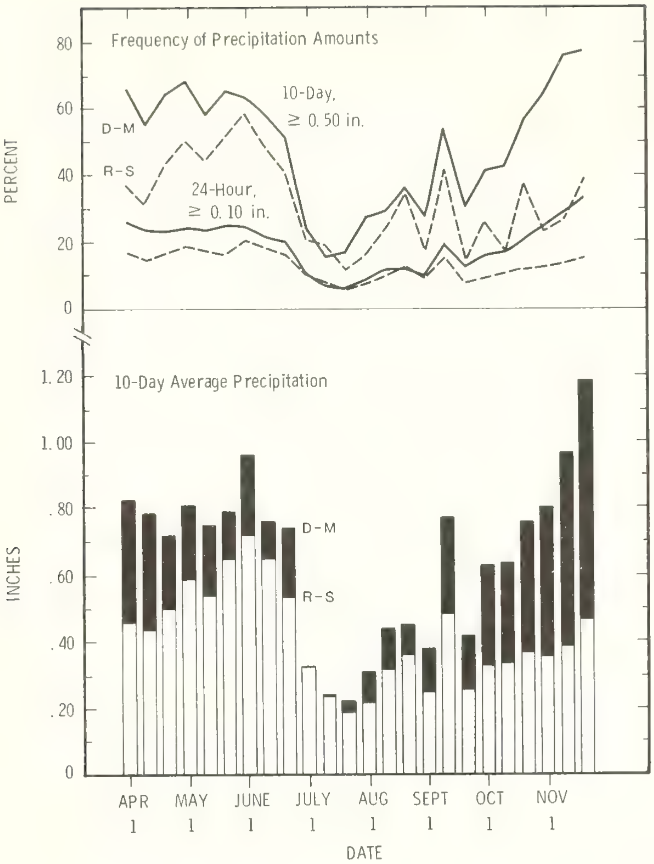

Figure 8—Ten-day average precipitation (bottom panel) and frequency of indicated 24-hour and 10-day amounts (top panel); based on period 1951-80. Shown for wetter and drier locations by two-station averages; for Dixie and McCall (D-M), shaded bars and solid lines, and Riggins and Shoup (R-S), open bars and dashed lines. Shoup 1951-80 values were estimates derived from 1966-81 data.

18 and 25 percent, respectively, for the drier and wetter station pairs. These chances converge to a minimum of about 7 percent during mid-July through early August. They diverge again during autumn, like the two sets of average precipitation amounts. The chance of 0.10 inch or more returns to above 25 percent at the wetter locations in early November.

Figure 9, based on data from four stations, further indicates a high correlation between a 10-day period's average precipitation and the frequency of 0.10-inch daily precipitation. Given the 10-day average, figure 9 may be used to estimate the climatic probability of a "wetting" rain during any portion of the fire season at other locations in the RNR.

SNOWFALL

Average annual snowfall in the RNR area (fig. 10) generally shows an increase with elevation and annual precipitation (fig. 4). The snowfall values represent sums of the observed daily snow accumulations, ideally measured before any reduction—by settling, melting, or wind action—occurs. Accuracy in the measurement or estimation task will vary among stations.

In the wilderness lower canyons, the average snowfall ranges from about 40 to 50 inches in the east and south to about 70 inches in the Campbell's Ferry area in the northwest. The snowfall decreases farther west along the main Salmon River, down to 10 inches at Riggins outside the wilderness. Snowfall is also scanty along the Salmon River east of the wilderness, down to 20 inches at Challis. Amounts at moderately wet locations in the west, near 5,000 to 6,000 ft, may approach or exceed 200 inches. For example, the 1951-80 average is 171 inches at McCall; 237 inches at Dixie. Annual snowfall at wettest locations, with about 60 inches precipitation, may average close to 500 inches.

Snowfall contributes more than 50 percent of the annual total precipitation at elevations above approximately 5,000 ft (fig. 11), excluding the dry Challis area east of the wilderness. The contribution may reach 70 percent at about

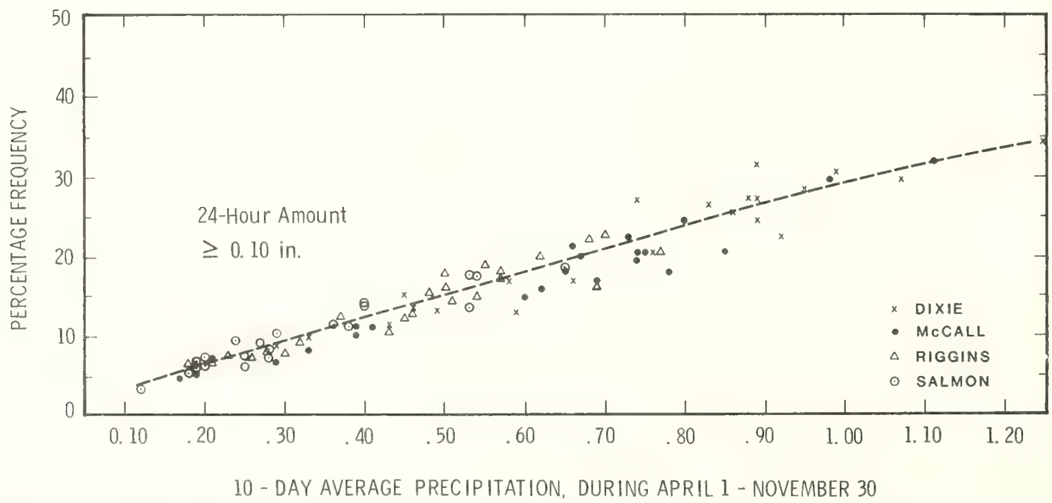

Figure 9—Relationship between frequency of days with precipitation ≥0.10 inch and the 10 (or 11)-day average precipitation, April-November. Based on 1951-80 data at indicated stations (1952-80 at Dixie). Curve fitted by eye.

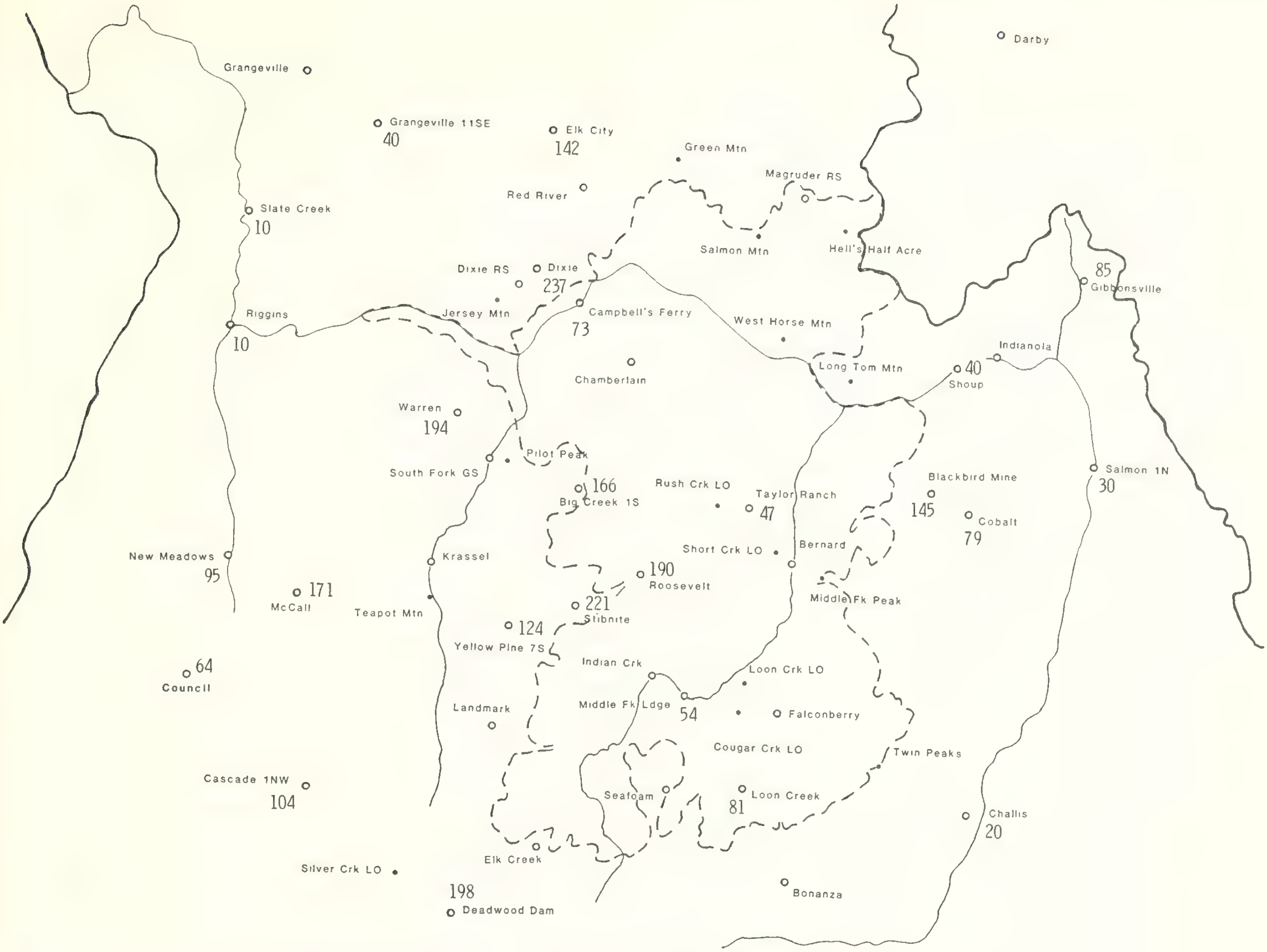

Figure 10—Average annual snowfall, inches. Based on or adjusted to 30 years (snow seasons), 1951-80, except averages are as observed in earlier years at Loon Creek and Roosevelt.

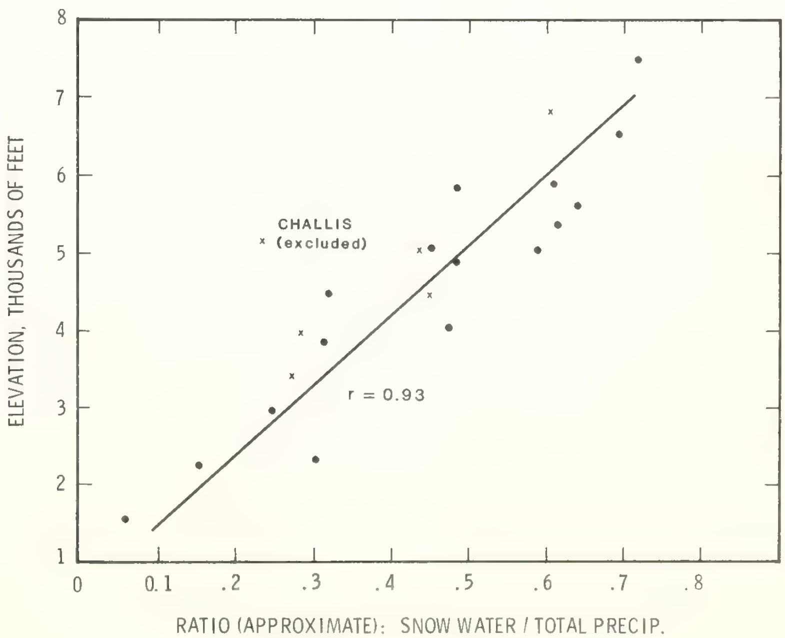

Figure 11—Proportion of annual total precipitation occurring as snowfall (approximate; see text) in relation to elevation, at stations in or near RNR. Based on or adjusted to period 1951-80, except as noted in figure 10 caption. X symbols denote stations on east side of wilderness. Calculated regression line excludes data from dry Challis location.

7,000 ft. The best-fit line, or linear regression (Freese 1967; Snedecor 1956), should not be extrapolated above this level, lest a snowfall contribution much above 80 percent is claimed.

The annual-snowfall/precipitation (S/P) ratios in figure 11 are approximate, largely due to approximation of the snowfall's water content; moreover, precipitation totals are subject to error because of wind-related gauge-catch deficiencies (Brown and Peck 1962; Linsley and others 1958; Weiss 1961). For figure 11, "snow water" was based on a multiplication of monthly average snowfall (table 14, appendix) by 0.10, with a constraint that the result could not exceed the corresponding monthly average precipitation. The 0.10 factor is probably too high as an actual average snowfall density (Landsberg 1958 and present author's experience), but this may be offset by deficiencies in reported snowfall.

The calculated S/P ratios, for 23 stations, show only a moderate correlation with annual precipitation; the coefficient r was 0.57. In a multiple correlation with both precipitation and elevation, r was 0.97.

Monthly Distribution—Monthly snowfall averages are included in table 14 (appendix). They are highest in January, reaching about 40 to 50 inches at 5,000- to 6,000-ft western locations, where most of the winter precipitation occurs as snow. The January averages are about 15 to 25 inches in lower canyon areas of the wilderness. Monthly and annual snowfall amounts for each year of record are listed for several stations in table 18 (appendix).

Annual and Monthly Extremes—Annual (seasonal) snowfall totals at the 5,000- to 6,000-ft west-side locations, in recent decades, have been as high as 344 inches at Dixie in 1971-72. Other extremes include 290 inches at Warren in 1966-67, 272 inches at McCall in 1970-71, and 266 inches at Deadwood Dam in 1968-69. These totals appear to be the highest in at least the past 50 years at such locations. Deadwood recorded 282 inches in 1931-32. Lowest totals in recent decades occurred in 1976-77 or 1980-81, with 59 inches at McCall; about 105 inches at Dixie.

In the lower canyons, available data show an extreme of 104 inches at Campbell's Ferry in 1978-79 (during 9 years of record), but only 14 inches there in 1980-81; about 125 inches may be estimated for 1971-72. A total of 73 inches occurred at Shoup in 1971-72 (low total in 1980-81 incomplete). Salmon had 56 inches in 1983-84; 9 inches in 1980-81. Elsewhere to the east, totals reached 145 inches at Gibbonsville and 132 inches at Cobalt in 1971-72.

Highest observed monthly snowfalls on the west side include 111 inches at Deadwood Dam in January 1950, 95 inches at Dixie in January 1953, and 90 inches at McCall in December 1971. In the lower canyons, monthly snowfall reached 52 inches at Campbell's Ferry in January 1982, 47 inches at Middle Fork Lodge in January 1980, and 29 inches at Shoup in January 1982; 23 inches at Salmon in December 1983.

Daily Snowfall—The high average snowfall at 5,000- to 6,000-ft west-side valley and canyon locations is accumulated from many days of snowfall—as would be inferred from the previously mentioned frequency of precipitation days. The annual number of days with 1.0 inch or more snowfall, based on about 20 to 30 recent years, averages 45 at McCall, about 60 at Deadwood Dam and Warren, and 72 at Dixie. Details concerning frequencies of these snowfall days, and of various daily snowfall amounts, are shown for several stations in table 19 (appendix). The above-mentioned west-side locations have a snowfall-day frequency of 30 to 40 percent or greater during the months December through March, except only through February at McCall. During January, these locations average 12 or 13 days with at least 1.0 inch snowfall.

In the lower canyons, there is an annual average of about 20 days with snowfall. The January average, as observed at Middle Fork Lodge and Shoup, is about 5 days.

Daily (24-hour) snowfall in extreme cases has reached 15 to 20 inches or greater. Deadwood Dam and McCall have both received 23 inches in 1 day, during October 1956 and January 1971, respectively, as did Deadwood in February 1933. Twenty inches fell at Warren on a March day in 1967.

Snow Depth; Snowpack—The average season of continuous snow cover (1 inch or greater) is confined mostly to the months December through February in the lower canyon bottoms; it may extend into early March. At the moderately wet 5,000-6,000-ft western locations, the snow cover is normally continuous from mid- or late November to sometime between early April and early May. These statements apply to level terrain. Earlier snowmelt, can, of course, be expected on south-facing slopes; later melt on shaded north slopes.

Details of average snow depths during the course of the season are given for climatic stations in table 2. Average depths in the lower canyons reach a maximum, near 10 inches, between mid- and late January. Seasonal maximum depth, occurring on any date, averages about 15 inches at Middle Fork Lodge; 17 inches at Campbell's Ferry. At the 5,000-6,000-ft western locations, average depths (based on 1961-85) reach a broad maximum centered in February or early March, with 30 inches at Big Creek, 33 inches at McCall, and 43 to 44 inches at Dixie and Deadwood Dam. The respective average seasonal maximum depths range from about 40 to 55 inches. Extreme depths of 75 to 84 inches have been observed at these higher locations.

A longer season of snow cover, and much greater depths, occur at the adjacent west-side snow-survey sites (table 3 and fig. 12), at about 6,000- to 7,500-ft elevations. The Deadwood Summit and Brundage Mountain snow courses have respective averages of 47 inches and 70 inches of snow remaining on June 1. Their first-of-month average depths reach 120 to 124 inches on April 1, with 46 to 48 inches water content. An extreme depth of 200 inches was measured at Deadwood Summit in 1974. On the drier east side, the Morgan Creek snow course, at 7,600 ft, has an April 1 snow depth averaging just 46 inches.

Table 2—Average and median[1] snow depth, inches, at middle and end of month, November-April, and average seasonal maximum depth (occurring on any date); based on or adjusted (Adj.) to period 1961-85. Highest and lowest seasonal values observed during available years of record since 1951; years shown under station name

Station		Nov. 15	Nov. 30	Dec. 15	Dec. 31	Jan. 15	Jan. 31	Feb. 15	Feb. 28	Mar. 15	Mar. 31	Apr. 15	Apr. 30	Season maximum
		Inches												
Big Creek 1 S	Avg.	3	9	13	20	24	27	29	30	28	26	19	7	39
Adj.	Med.	1											2	
1949-67	High, yr													62 1965
	Low, yr													11 1963
Blackbird Mine	Avg.	4	10	17	21	24	28	30	32	30	25	14	3	40
Adj.														
Campbell's Fy.	Avg.[2]													17
Adj., 1977-85	High, yr													36 1979
	Low, yr													4 1981
Cascade 1 NW	Avg.	1	4	7	12	14	17	17	15	12	7	1	0	24
	Med.	0	4								1	T	0	
1951-85	High, yr													47 1952
	Low, yr													8 1961
Cobalt	Avg.	1	3	6	10	13	15	14	13	11	6	1	T	19
	Med.	0	3								3	0	0	
1962-82	High, yr													30 1964
	Low, yr													3 1981
Deadwood Dam	Avg.	4	14	22	33	37	42	44	44	43	39	28	13	55
Adj., 1951-74	High, yr													84 1971
	Low, yr													18 1963
Dixie	Avg.	3	11	21	28	36	41	43	44	43	38	30	18	52
Adj.	Med.	1	10									33	15	
1962-85	High, yr													78 1972
	Low, yr													28 1963, 1981
Elk City	Avg.	1	5	8	13	17	20	19	18	17	11	3	1	30
	Med.	0	5								12	T	0	
1959-85	High, yr													50 1964
	Low, yr													11 1973
Gibbonsville	Avg.	T	4	8	14	18	19	18	15	11	4	1	0	27
Adj.														
McCall	Avg.	2	10	16	23	28	33	33	33	29	20	5	0	44
	Med.	0	11								22	1	0	
1951-85	High, yr													75 1952
	Low, yr													17 1977
Middle Fk Lodge	Avg.	1	3	5	7	9	9	8	6	3	1	0	0	15
Adj.	Med.	0									0	0	0	
New Meadows	Avg.[2]													26
1951-85	High, yr													48 1952
	Low, yr													8 1963, 1977
Salmon 1 N	Avg.[2]													7
Adj., 1951-85	High, yr													18 1984
	Low, yr													1 1954
Shoup	Avg.	0	3	5	8	11	10	8	5	2	0	0	0	16
Adj.	Med.	0	1	3				5	1	0	0	0	0	
1967-85	High, yr													32 1982
	Low, yr													5 1981
Stibnite	Avg.	4	12	19	26	30	34	35	36	34	30	22	10	46
Adj.														
Warren	Avg.	3	11	16	24	29	34	36	37	39	35	27	15	47
	Med.	1	11									24	9	
1960-85	High, yr													77 1967
	Low, yr													21 1963
Yellow Pine 7 S	Avg.	2	6	10	18	21	25	25	26	23	17	7	1	35
Adj.	Med.	0										3	0	
1971-85	High, yr													47 1971
	Low, yr													13 1977

[1]Median shown only in early and late season, when difference from average may be notable.
[2]Monthly averages unavailable (required data not published or inadequate for calculations).

Table 3—Snowpack data. Average snow depth (SN), water content (WC), and density (DS, equal to SN/WC) on about first day of month, at snow courses adjacent to RNR; based on or adjusted to period 1961-85. SN and WC are in inches. Maximum and minimum values observed during 1951-85, except as noted below snow course name. E denotes estimated (data missing). Blank columns denote unavailable or insufficient data. Letters in parentheses are snow course identifiers used in figure 2

Snow course, elevation (ft)		Jan. 1 SN	Jan. 1 WC	Jan. 1 DS	Feb. 1 SN	Feb. 1 WC	Feb. 1 DS	Mar. 1 SN	Mar. 1 WC	Mar. 1 DS	Apr. 1 SN	Apr. 1 WC	Apr. 1 DS	May 1 SN	May 1 WC	May 1 DS	June 1 SN	June 1 WC	June 1 DS
Banner Summit[1] 7,040 (BAN)	Avg.	50	14.0	0.28	70	21.5	0.31	79	26.0	0.33	84	30.1	0.36	68	29.0	0.42			
Big Creek Smt. 6,580 (BGC)	Avg.	56	15.7	0.28	81	25.2	0.31	93	31.5	0.34	100	37.5	0.38	87	37.6	0.43	39	19.7	0.51
(1963-85 for Jan. 1)	Max.	104	31.2		126	42.1		129	47.7		135	52.5		127	58.6		89	47.4	
	Min.	10	1.8		17	3.4		25	4.6		40	10.9		14	5.0		0	0.0	
Brundage Mtn. 7,560 (BRG)	Avg.	72	20.9	0.29	96	30.8	0.32	111	40.1	0.36	124	48.3	0.39	114	49.8	0.44	70	36.5	0.52
1965-85	Max.	106	36.8		144	47.8		147	56.2		165	64.5		166	67.8		117	62.0	
	Min.	10	2.2		18	5.2		32	5.9		60	15.8		18	6.4		14	6.2	
Deadwood Smt. 6,860 (DWD)	Avg.	74	21.5	0.29	99	32.0	0.32	113	39.8	0.35	120	46.2	0.38	99	45.8	0.46	47	24.6	0.52
(1963-85 for Jan. 1)	Max.	142	44.9		167	57.6		172	64.5		200	78.0		161	71.5		121	64.7	
	Min.	11	1.7		16	3.2		28	5.5		49	11.6		3	0.9		0	0.0	
Mill Crk Smt. 8,800 (MLC)	Avg.	39	10.2	0.26	54	16.0	0.30	61	19.4	0.32	67	23.0	0.35	62	24.5	0.39			
1963-85[2]	Max.				92	32.8		93	35.3		105	39.0		89	38.2				
	Min.	8	1.0		12	2.1		16	2.6		33	6.7		10	3.7				
Moose Creek 6,200 (MSC)	Avg.	33	7.4	0.22	45	12.1	0.27	50	15.2	0.30	51	17.0	0.33	38	14.5	0.38			
(1967-85 for Jan. 1, May 1)	Max.	49	14.8		67	19.2		72	25.6		72	25.4		70	25.4				
	Min.	15E	2.5E		21	4.2		24	4.6		30	7.7		0E	0.0E				
Morgan Creek 7,600 (MGC)	Avg.	26	5.9	0.23	38	9.8	0.26	43	12.2	0.28	46	14.3	0.31	34	12.7	0.37			
1963-85	Max.	63	14.6		77	22.6		65	24.2		65	23.6		65	21.8				
	Min.	5	0.6		10	1.8		12	2.0		29	5.7		0	0.0				
Mountain Meadows 6,360 (MTM)	Avg.							65	20.8	0.32	67	23.8	0.36	57	22.7	0.40			
1965-85[3]	Max.				85	24.6		93	32.7		98	36.0		93	39.8				
	Min.										44	11.2		24	7.2				
Nezperce Pass 6,570 (NZP)	Avg.							48	15.0	0.31	50	17.8	0.36	38	15.4	0.40			
	Max.							72	22.7		74	27.2		69	28.0				
	Min.							26	7.0		28	8.8		5	2.1				
Secesh Summit 6,520 (SEC)	Avg.	54	15.5	0.29	76	24.5	0.32	87	30.7	0.35	91	36.0	0.40	76	34.3	0.45	28	14.0	0.50
1967-85[4]	Max.	84	25.4		124	45.6		130	50.6		135	59.8		128	60.3		89	46.9	
	Min.	12	1.7		18	4.5		27	5.6		43	11.6		8	2.3		0	0.0	

[1]Adjusted averages from 1979-85 data.
[2]Except 1951-85 for Apr. 1.
[3]Jan. 1-Mar. 1 data through only 1973.
[4]For Apr. 1. Data commence in 1969 for Mar. 1; in 1972 or 1973 for other dates.

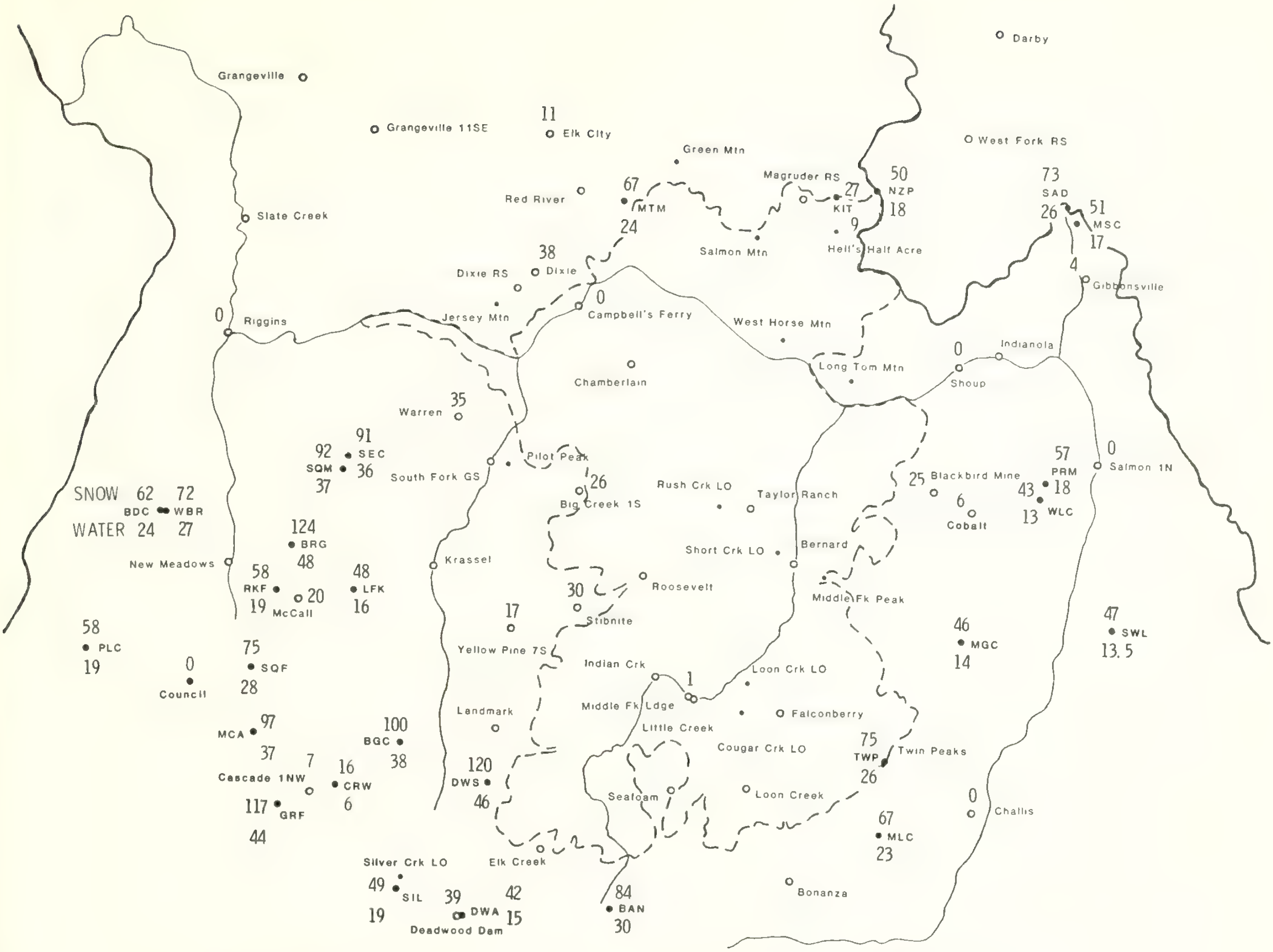

Figure 12—Average snowpack or snow cover, inches, near April 1; data from snow courses (identified in table 11, appendix) and climatic stations, based on or adjusted to period 1961-85. Top or only number is snow depth; bottom number, water content.

Runoff

Figure 13 depicts the annual (water-year) regime of cumulative runoff, averaged for several drainages in the western RNR area. An index of cumulative precipitation is included for comparison. Calculation details are given in the figure legend. Drainage and gauging point locations are shown in figure 14. Over the period of a year the streamflow, or runoff, closely represents the difference between drainage average precipitation and evapotranspiration (combined evaporation and transpiration); changes in groundwater storage are generally small.

The effect of water storage in snowpack and subsequent release with springtime snowmelt is very evident in figure 13. At the end of April, the cumulative water-year precipitation averages about 73 percent of total, while cumulative runoff lags at 23 percent of its total. This difference is narrowed to a few percent by the end of June. Overall, for the combined drainages, May normally accounts for 27 percent of the yearly runoff; June, 33 percent. A return to near base flow occurs in August, with monthly runoff during September through March averaging 2 or 3 percent of the total. Monthly details in table 4 indicate a similar runoff regime in the drier Panther Creek drainage to the east.

For the entire Salmon River drainage area above White Bird, ID (fig. 14), covering 13,550 mi^2, much of this outside the RNR boundary, the 1951-80 average annual runoff volume is about 8,786,000 acre-ft. About 1,125,000 acre-ft are accrued in the 770-mi^2 Middle Fork Salmon drainage area above Middle Fork Lodge.

The areal-average runoff depth equivalents are mapped in figure 14. These depths—calculated as: runoff volume/drainage area—reflect the relative amounts of areal-average precipitation. Runoff depths are near 25 inches for the southwestern drainage areas but only 7 inches for Panther Creek. Areal precipitation may average at least 45 inches for the upper Middle Fork Salmon drainage, given the 27-inch runoff depth and perhaps 18 inches or more annual evapotranspiration (Rosa 1968). With much lower precipitation amounts indicated in the canyon bottom and other locations (fig. 4), 60-inch precipitation amounts may be inferred for some wetter locations—in line with indications from adjacent west-side snow courses.

Highest flows in the RNR area, in at least the past 75 years, apparently occurred during June 16-18, 1974. The Salmon River at White Bird reached a momentary peak of 130,000 ft^3/s (10.7 times the 1951-80 annual average flow); the Middle Fork Salmon at Middle Fork Lodge, 20,900 ft^3/s (13.4 times the annual average).

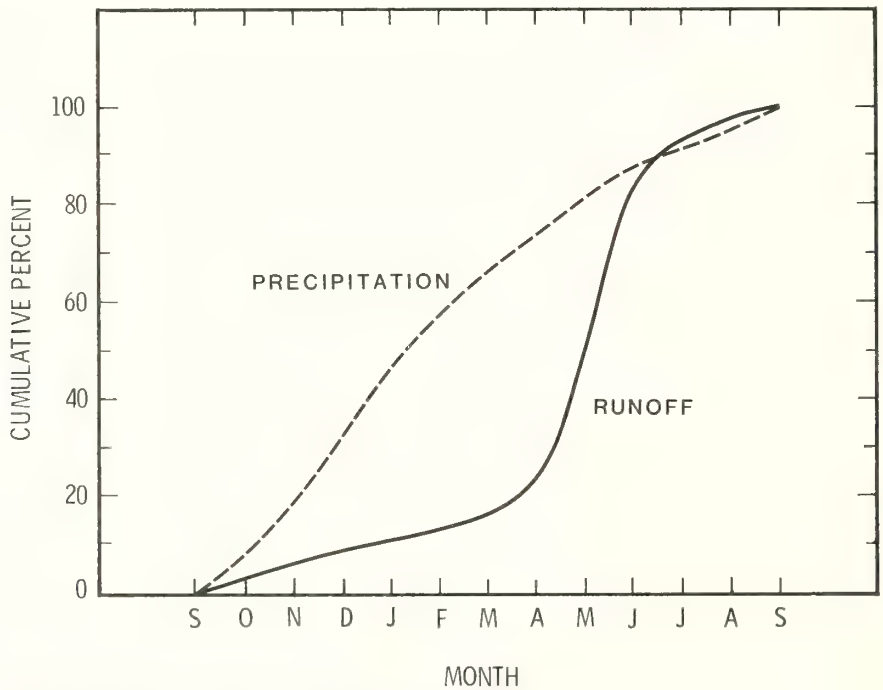

Figure 13—Comparison of average water-year regimes of cumulative precipitation and runoff in or near RNR, wetter western and southwestern area. Curves show cumulative percentage of yearly total attained at end of respective months. From data based on or adjusted to 30-year period 1951-80. Runoff represents unweighted average for four drainages or subdrainages (fig. 14): Big Creek, Johnson Creek, South Fork, and upper Middle Fork Salmon River. Precipitation is unweighted average for five stations (fig. 4): Big Creek 1 S, Big Creek Summit, Deadwood Dam, Middle Fork Lodge, and Yellow Pine 7 S.

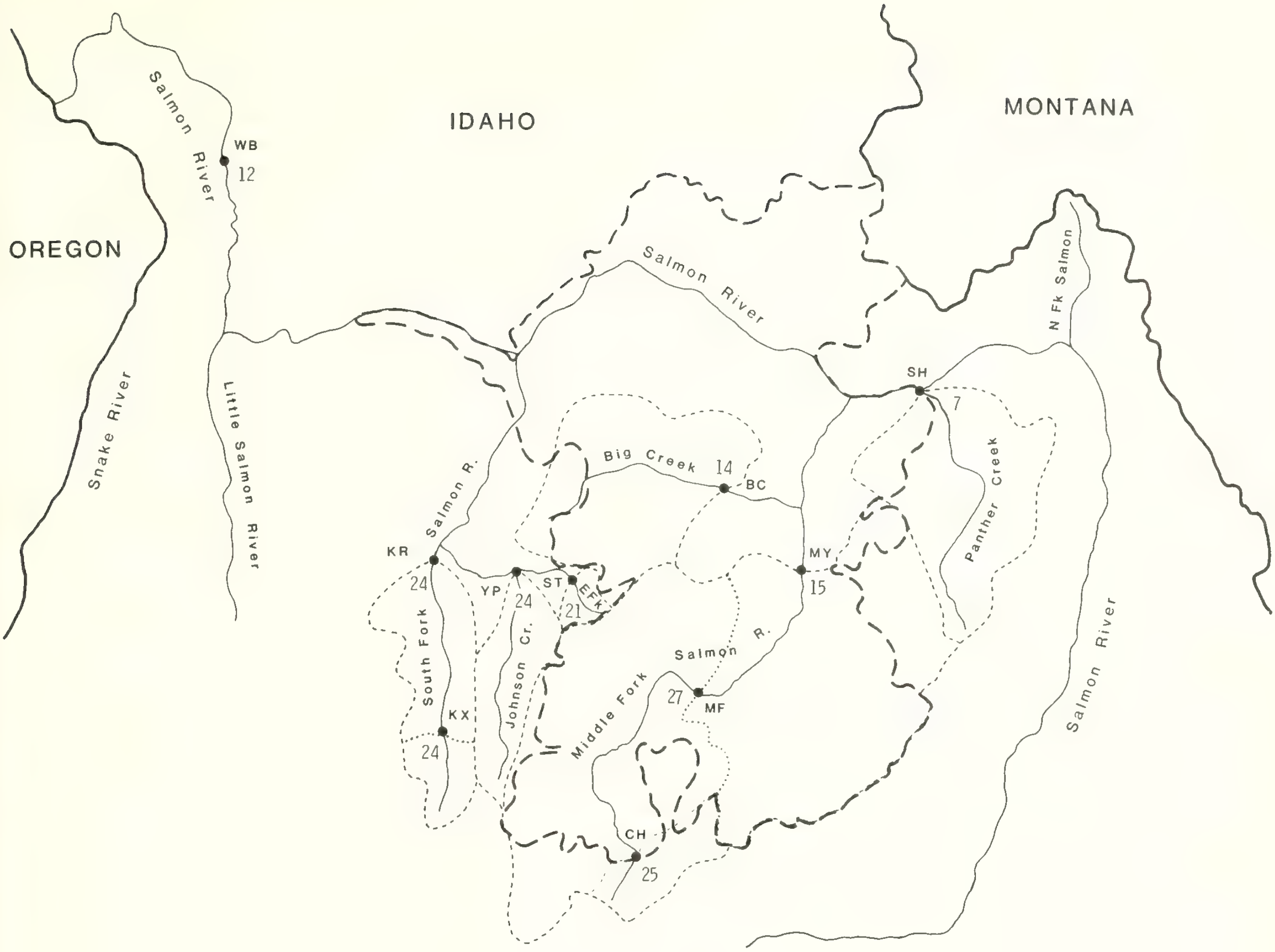

Figure 14—Average yearly runoff, equivalent depth in inches, from drainages or subdrainages in or adjacent to RNR (boundary shown by heavy dashed line). Drainage areas, above gauging points (heavy dots), are shown within fine-dashed or dotted lines. EFk denotes East Fork of South Fork Salmon River. Gauging points are identified in table 11 (appendix). Runoff value at White Bird (WB) is for overall 13,550-mi^2 drainage area of Salmon River.

Table 4—Monthly average runoff from drainages in RNR area; in percentage of annual total. Based on or adjusted to period 1951-80. Drainage locations shown in figure 14

Drainage, area (mi^2), gauging point	Total	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
	Thousand acre-feet	*Percent*											
Big Creek 470, near Big Creek (19 mi east of Post Office)	361	3.4	2.9	2.6	2.4	2.1	2.6	6.7	24.7	32.6	12.1	4.5	3.4
Johnson Creek 213, at Yellow Pine	269	2.5	2.4	2.2	2.2	1.9	2.1	5.7	29.7	36.1	10.0	3.0	2.2
Middle Fk Salmon River 770, at Middle Fk Lodge	1,124	3.7	3.4	2.9	2.7	2.6	2.9	7.1	26.0	30.4	10.4	4.5	3.4
Panther Creek 529, near Shoup	187	3.5	3.1	2.9	2.7	2.5	3.0	6.0	25.2	32.3	10.6	4.6	3.6
Salmon River 6,270, near Shoup	2,226	5.4	5.4	5.0	4.8	4.4	5.0	6.6	17.3	25.3	11.4	5.0	4.4
Salmon River 13,550, at White Bird	8,786	3.7	3.6	3.4	3.2	3.1	3.9	7.6	23.7	29.7	10.7	4.1	3.3
South Fk Salmon River 92, near Knox	116	3.0	2.9	2.9	2.8	2.4	3.0	8.1	27.9	32.3	8.9	3.3	2.5

Thunderstorms

The main season of lightning (or thunderstorm) activity in this area extends from May to September. Records from surrounding Weather Service airport stations (Kessler 1986) indicate that June, July, and August are generally the months of peak occurrence. This report presents details only for July and August, the months of greatest storm data availability from lookouts and greatest occurrence of lightning-caused fires.

The larger areal pattern of July and August thunderstorm frequency is shown in figure 15. The plotted values indicate a maximum occurrence in the southwestern Montana mountains and a decrease westward across Idaho. Across the RNR, the average July-August storm frequency appears to range from about 10 days in the southwest to 16 days in the northeast. These numbers refer to storms within about 20 miles of a given point; the contributing lookout data are mostly from special observations obtained for lightning research at IFSL.

A large proportion of the July-August thunderstorms start in the afternoon. About 60 percent begin between 1200 and 1759 m.s.t. over most of the RNR (fig. 16), with the peak beginning hour 1300-1359 or 1400-1459. The individual storms have been arbitrarily defined by at least 3 hours time separation between reported thunder or lightning occurrence (within 20 miles). With this definition, there was usually only one storm per storm day—tabulated here as the 24-hour period beginning at 0700 m.s.t.

Storm activity is at a minimum in the early morning hours. Only about 7 to 10 percent of the storms during 1956-70 began between 0300 and 0859 m.s.t.

The Lightning Activity Level (LAL) (Deeming and others 1977) may reach "5" in about 15 percent of the July-August storms (fig. 17). This is based on maximum 15-minute counts of visually observed cloud-to-ground lightning discharges, recorded during 1960-70. The LAL was a milder "2" in about 50 to 60 percent of these storm cases.

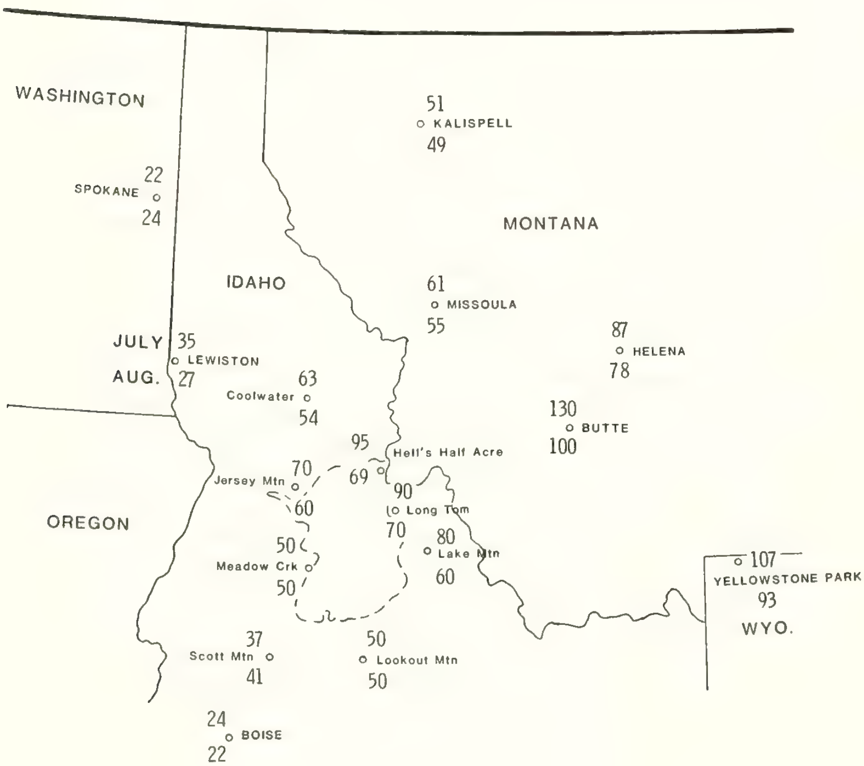

Figure 15—Average number of days per 10 years with observed thunderstorms, during July (top number) and August (botttom number). Data from lookouts during 1956-70 (shorter records adjusted to complete period; averages in round numbers) and airport stations (upper case letters) during 1951-75. Exceptions are averages for Butte airport, based on 1939-51, and Yellowstone Park (Headquarters), based on 1917-40.

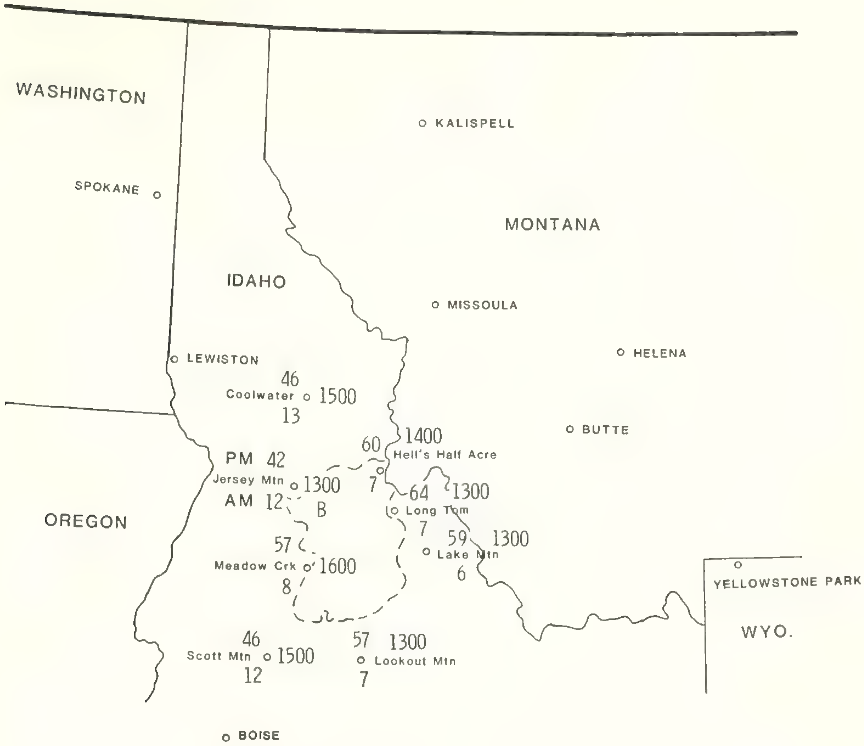

Figure 16—Percentages of defined thunderstorms (see text) beginning during 6-hour period 1200-1759 m.s.t. (top number)(PM), and 0300-0859 m.s.t. (bottom number)(AM). Based on storms observed within 20-mile radius of lookout. Peak beginning time (smoothed), in hourly increments, is shown at right; letter B, at Jersey Mountain, denotes broad afternoon peak. Based on available storm cases during 1956-70.

Figure 17—Percentage of thunderstorms with Lightning Activity Level (National Fire Danger Rating System) of "2" (top number) (L2), and "5" (bottom number)(L5). Based on maximum 15-minute counts of cloud-to-ground lightning within 20-mile radius of lookout, in available storm cases during 1960-70. Numbers of cases range from 42 at Meadow Creek to 142 at Hell's Half Acre.

Temperature

ANNUAL REGIME

The general yearly course of average temperatures in the RNR, measured about 5 ft above the ground, is portrayed in figure 18. Individual station averages are listed in table 20 (appendix). The averages—calculated normals—for these and additional stations are mapped in figure 19 for January, normally the coldest month, and in figure 20 for July, normally the warmest month. Comparability between stations is affected somewhat by differences in daily observation time and possibly by large-scale horizontal temperature gradients (Finklin 1983b, 1986; Rumbaugh 1934). For example, in the Idaho-Montana area, maximum temperatures based on 24-hour periods ending around 1600 or 1700, local time, commonly average 2 °F higher during spring and summer months than those read in early morning (or at midnight).

In general, average daily maximum temperatures in the lower canyons range from 30 to 35 °F in January to the upper 80's and lower 90's in July. Corresponding average minimum temperatures range from about 15 to 20 °F to the upper 40's and lower 50's. In the west-side valleys and canyons, at 5,000-6,000 ft, average maximums are generally 30 to 32 °F in January; in the upper 70's to lower 80's in July. The corresponding minimums range from about 5 to 10 °F to 35 to 45 °F.

Statistical details pertaining to daily maximum and minimum temperatures are presented for year-round and seasonal (fire-weather) stations in table 21 (appendix). Frequencies of various daily values are shown in table 22 (appendix).

The observed temperature values may be influenced by local shading, radiation, transpiration, and air drainage effects—depending on the immediate topography and surroundings and the related sheltering or exposure to wind (Schroeder and Buck 1970). Smoothing out some of the local daytime and nighttime variations are monthly "mean" temperatures, which in United States climatic practice are calculated as arithmetic averages of the maximum and minimum temperatures. The normal monthly means in the lower canyons thus range generally from 22 to 28 °F in January to 67 to 73 °F in July. The overall annual means are about 44 to 50 °F. In the 5,000- to 6,000-ft valleys and canyons, the range is generally from 18 to 21 °F in January to 57 to 63 °F in July, with annual means 37 to 41 °F.

Mean-temperature statistics are given in table 23 (appendix). The monthly and annual values for each year at McCall and Challis are listed in table 24 (appendix).

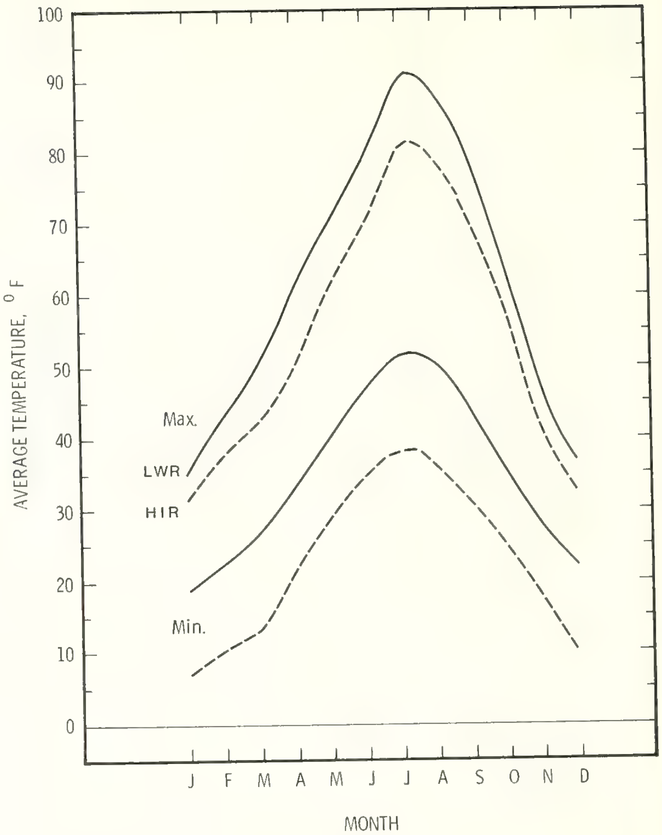

Figure 18—Average daily maximum and minimum temperatures, annual pattern, in or near RNR; averages for two groupings of stations. Based on or adjusted to 1951-80 normal period. HIR denotes higher valley or canyon locations on west side, at 5,000-6,000 ft; data from Dixie, Warren, Big Creek 1 S, Yellow Pine 7 S, and Deadwood Dam. LWR denotes lower canyon locations; data from Middle Fork Lodge, Shoup, Campbell's Ferry, and Riggins.

RELATIONSHIP TO ELEVATION; INVERSIONS

Average temperatures tend to decrease with elevation, particularly during daytime, but the available data show little overall decrease in the January maximums (fig. 19). This may reflect both frontal and local temperature inversions (Critchfield 1974; Schroeder and Buck 1970), aided by cold air entrapment and possible topographic shading in sheltered canyon bottoms, as well as shading by low-lying clouds (Benedict 1986; Martin 1986). Topographic shading is reported during winter at the Taylor Ranch station site, where the January maximum of 28 °F (with a morning observation time) is the second lowest among the stations in figure 19. Higher readings were believed likely had the station been located just 200 yards away (Holly Akenson 1987). January temperatures are notably higher to the west in the Riggins-Slate Creek area, where inversions are inhibited by greater wind movement, often strong in winter (Wallace 1987). This wind, typically from the south, may also have a downslope warming effect.

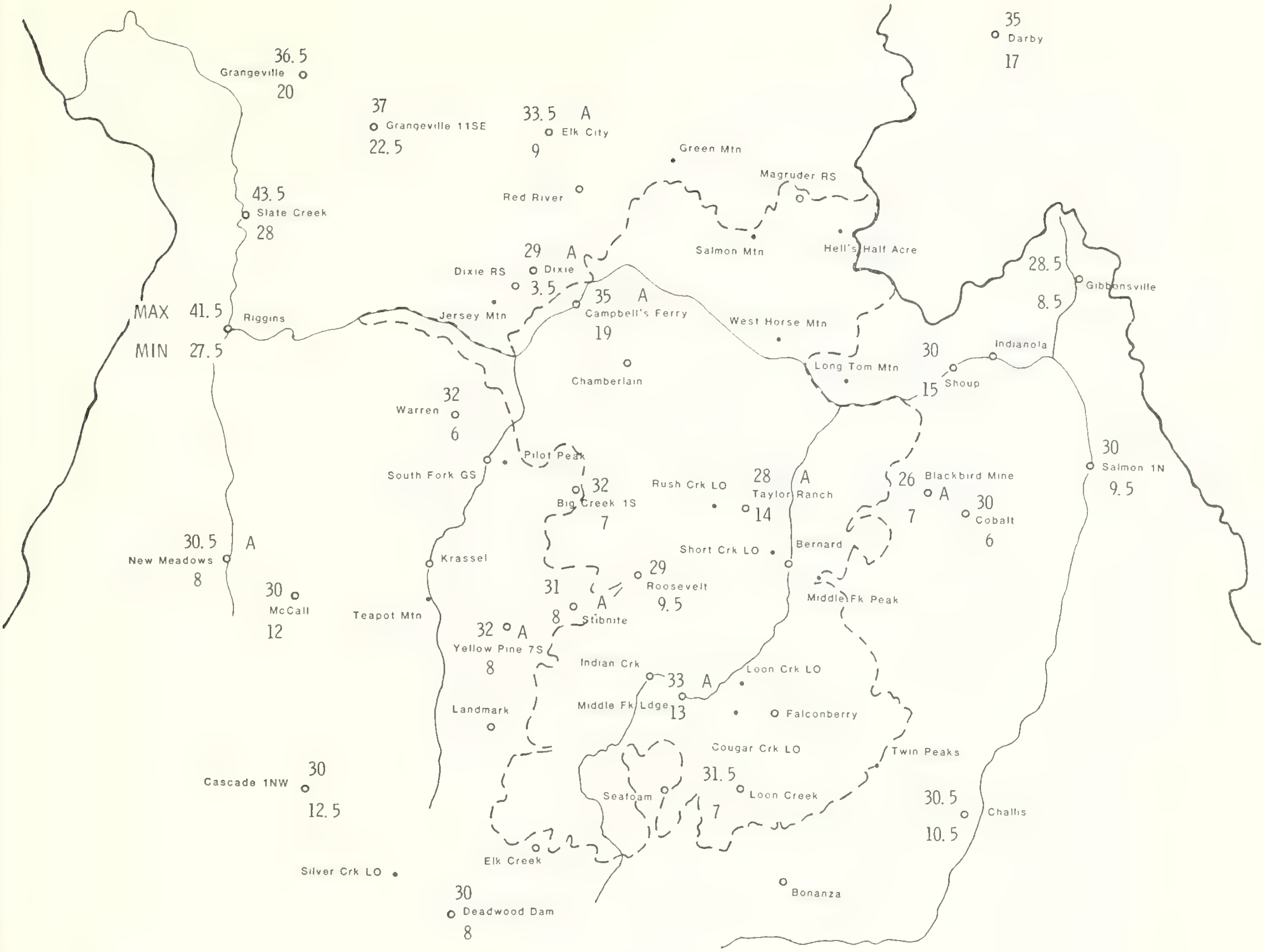

Figure 19—Average daily maximum and minimum temperatures, °F, during January. Based on or adjusted to 1951-80 normal period. For 24-hour period ending at generally mid- or late afternoon observation time or in morning (indicated by letter "A").

Temperature inversions are more commonplace at night during most of the year. Characteristic of fair weather, favoring radiational cooling, these nighttime inversions are particularly evident in the summer and early autumn temperature averages. Thus, in July, average minimum temperatures in the lower canyons may be similar to those at adjacent lookouts, 4,000 to 5,000 ft higher in elevation, though the maximum temperatures differ by about 20 °F. Examples in figure 20 include South Fork Guard Station and Pilot Peak, Bernard and Short Creek Lookout, and Campbell's Ferry and Jersey Mountain. July average minimums in the higher valleys and canyons are mostly 10 to 15 °F lower than those at neighboring lookouts.

Temperature-elevation relationships are shown in figures 21 and 22. The regression-line "lapse rate" of summer (July-August) maximum temperatures (fig. 22), 4.0 °F per 1,000 ft (including lookout data), is noticeably steeper than that for winter (December-January) (fig. 21), and the correlation is much better. For the 37 canyon and valley stations alone, the lapse rate for summer maximums was 3.7 °F per 1,000 ft (with r, -0.94). The rate obtained for 20 canyon and valley stations in winter was just 1.5 °F per 1,000 ft (r, -0.61); this decreases to 0.8 °F per 1,000 ft (r, -0.42) when the two end-point stations, Riggins and Stibnite, are excluded.

The summer "mean" temperatures, influenced by nighttime inversions, quite evidently require separate treatment of the mountain (lookout) station data. The means at 8,000-ft lookouts, about 58 to 60 °F, are similar to those in valleys or canyons at 5,500-6,000 ft. For the canyon and valley means, the summertime lapse rate per 1,000 ft is 4.0 °F, compared with 2.7 °F in winter (2.2 °F, excluding Riggins and Stibnite). The lookout mean temperatures show a summertime lapse rate of only 2.9 °F per 1,000 ft, due mainly to a slow elevational decrease in minimum temperatures. This smaller rate, which may in part be a peculiarity of the data sample, would indicate a modification of the free-atmosphere conditions.

This possibility is suggested by Boise radiosonde (upper-air sounding) data, obtained from monthly "Climatological Data, National Summary" for a 2000 m.s.t. observation time during 1950-56 and for 0500 during 1957-67. Average

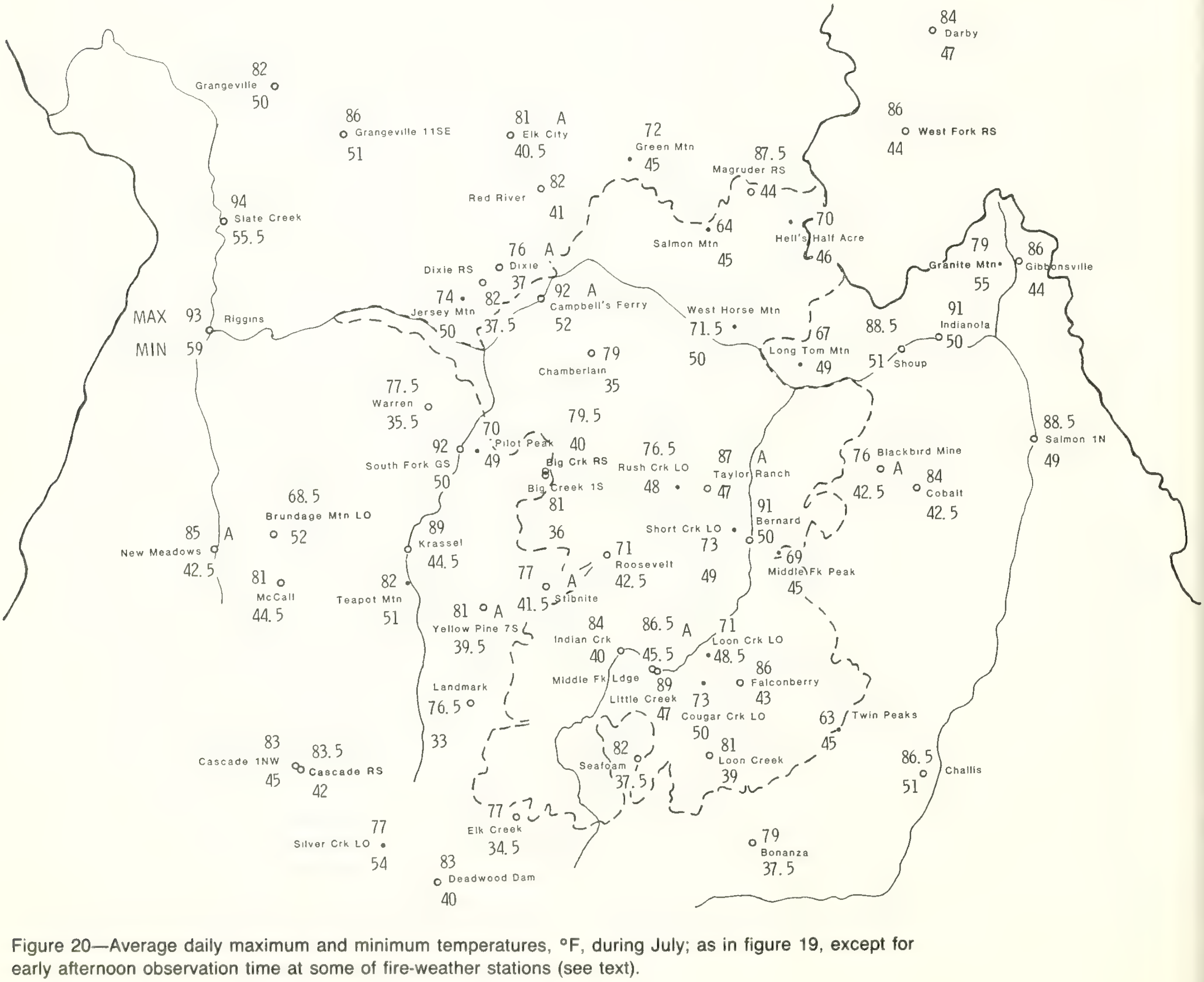

Figure 20—Average daily maximum and minimum temperatures, °F, during July; as in figure 19, except for early afternoon observation time at some of fire-weather stations (see text).

July lapse rates for these times (and periods) between about 5,000 ft and 10,000 ft in the free atmosphere were 4.8 and 3.8 °F, respectively, per 1,000 ft. The corresponding average January lapse rates were 3.0 and 2.4 °F per 1,000 ft.

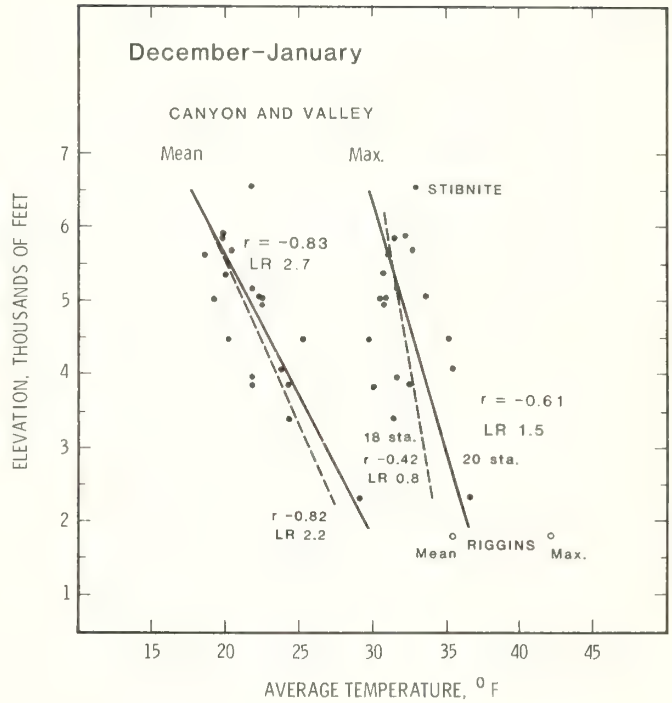

Figure 21—Relationship between average daily temperatures and elevation, December-January; at canyon and valley stations in or near RNR. Based on or adjusted to period 1951-80. Averages at stations with morning observation time (fig. 19) have been raised 1.0 °F for better compatibility with other stations, having afternoon observation time (see text). LR (lapse rate) is slope of calculated regression line, converted to °F per 1,000 ft; for 20 stations (solid line) and 18 stations (dashed line), excluding Riggins and Stibnite. Mean temperature is based on arithmetic average of daily maximum and minimum values.

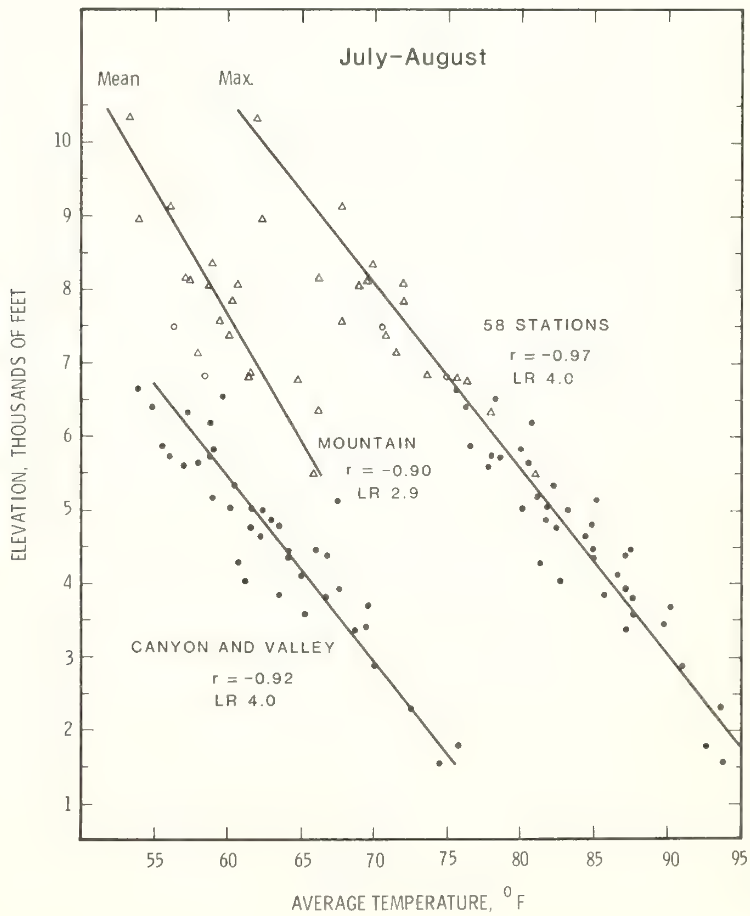

Figure 22—Relationship between average daily temperatures and elevation, July-August, shown as in figure 21; for canyon and valley stations (dots) and mountain (lookout) stations (triangles). Average maximums have been raised 2.0 °F and means 1.0 °F at stations with morning observation time (fig. 20), for better compatibility (see text). Means at two high-elevation mine locations (open circles) are not included in regression-line calculation.

EXTREME TEMPERATURES

Observed highest and lowest temperatures of record are summarized in table 5. The extreme-maximum values, like the average summer daytime temperatures, generally decrease with elevation. The extreme-minimum values also show an overall decrease, comparing valley or canyon locations, but much local variation may occur. There is relatively small year-to-year variation in the annual extreme maximums, with standard deviations about 3 °F. The more variable annual extreme minimums have standard deviations of 7 to 9 °F.

Data from table 5 and additional stations indicate that extreme maximums in the past 55 years (since 1930) at lower canyon locations have ranged from about 105 to at least 114 °F—observed at Campbell's Ferry and Riggins in August 1961. In an "average" year, these extremes range

Table 5—Annual extreme maximum and minimum temperatures, °F: Average (Avg.), standard deviation (SD), and highest and lowest observed. Averages based on or adjusted to period 1951-80; SD for 1951-80 or indicated years; highest and lowest for available years during 1951-85

	Extreme maximum			Extreme minimum		
Station	Avg. annual	SD	Highest, mo, yr	Avg. annual	SD	Lowest mo, yr
Big Creek 1 S 1951-67	93	2.6	97 July '59, '60; Aug. '61	−30	8.5	−42 Dec. '64
Blackbird Mine	88			−19		
Campbell's Ferry 1961-85[1]	106	2.9	114 Aug. '61	−6		−18 Jan. '79
Cascade 1 NW	94	2.6	100 July '60; Aug. '61	−20	7.8	−36 Jan. '62; Dec. '78
Challis	97	2.4	103 Aug. '61	−16	8.8	−34 Dec. '83
Cobalt 1966-85	96	2.4	100 July '73	−22	7.3	−34 Dec. '78
Deadwood Dam[2] 1949-74	95	2.7	101 Aug. '61	−29	6.1	−38 Jan. '59, '62
Dixie	90	2.8	99 Aug. '61	−32	8.0	−48 Dec. '64
Elk City	96	3.2	103 Aug. '61	−30	7.8	−48 Dec. '83
Gibbonsville 1964-79, 84-85	96	1.7	100 July '85	−22	7.4	−36 Dec. '78
McCall[3]	92	2.9	98 Aug. '61	−18	6.6	−31 Jan. '62; Dec. '83
Middle Fork Lodge 1971-85	100	1.9	103 July '73, '85	−12	7.4	−28 Dec. '83
New Meadows	97	2.8	104 July '60	−26	8.0	−45 Dec. '83
Riggins	107	3.2	114 Aug. '61	4	8.6	−10 Jan. '57
Salmon[4]-Salmon 1 N	100	2.5	105 July '60	−19	9.7	−35 Feb. '56
Shoup[5] 1966-85	99	1.7	104 July '85	−10	7.7	−23 Jan. '79
Stibnite	89			−18		
Warren 1960-85	89	2.5	94 Aug. '61	−30	8.9	−45 Dec. '78
Yellow Pine 7 S 1971-85	93	2.0	96 Aug. '72; July '73	−23	7.3	−35 Jan. '79
Hell's Half Acre 1954-83	82	2.8	86 July '60; Aug. '61, '69			

[1]For maximum; 1977-84 for minimum.
[2]Lowest prior to 1951, −45 in Jan. '43; −48 at former Deadwood site in Feb. '33.
[3]Highest prior to 1951, 99 in July '36; lowest, −35 in Jan. '43.
[4]Station moved 1 mile north in 1968. Highest prior to 1951, 106 in July '36; lowest, −37 in Jan. '37.
[5]Maximum of 107 observed at nearby Indianola in July '60 (Aug. '61 data not available); also 107 in July '60 at Bernard and Krassell, 104 at Little Creek.

from about 100 to 107 °F. The corresponding 55-year extreme minimums are generally −20 to −30 °F, although only −10 °F at Riggins; average annual extremes are about −5 to −15 °F (but a milder +4 °F at Riggins). At 5,000- to 6,000-ft valley and canyon locations, the extreme maximums and minimums have reached about 95 to 100 °F and −35 to −50 °F, respectively; for example, 101 °F at Deadwood Dam in August 1961 and −48 °F at Deadwood (near the dam location) in February 1933 and at Dixie in December 1964. The average annual values are about 90 to 95 °F and −18 to −32 °F. Extreme maximums have reached the upper 80's at lookout locations near 8,000 ft.

FREEZING TEMPERATURE THRESHOLDS

The "frost-free" or freeze-free season, based on a 32 °F minimum temperature, is virtually nonexistent in some of the higher valley and canyon locations. This absence may apply nearly as well for a 28 °F threshold, sometimes used to define a "killing frost"—particularly in basinlike terrain which serves as a pond for nighttime cool-air drainage (Geiger 1965; Schroeder and Buck 1970). Examples, shown in table 6, include the stations at Big Creek, Dixie, and Warren; Chamberlain (fig. 20), with similarly low average minimum temperatures, is evidently also in this category. At these locations, the period between 28 °F occurrences averages at most 35 to 40 days, from early July to mid-August, but this temperature can occur on any date during individual summers. Not shown, the corresponding interim at the former Landmark Ranger Station averaged 9 days (using July 31 as a season division point). Following these frosty summer mornings, maximum temperatures are commonly in the 70's and 80's.

The season between 32 °F occurrences averages 65 days at McCall, from late June to late August; 106 days for 28 °F. The listed standard deviations (table 6) indicate that in two-thirds of the years, "last" and "first" frosts should occur within about 15 days of the average dates. In the lower canyons, the season averages about 100 to 150 days for 32 °F, increasing farther west to 182 days at Riggins; about 140 to 180 days for 28 °F, but up to 218 days at Riggins.

In extreme cases, July-August minimum temperatures have been as low as 25 to 35 °F in the lower canyons (though just 42 °F at Riggins) and 20 to 25 °F in the 5,000- to 6,000-ft valleys and canyons. Minimums in the teens have occurred at Landmark Ranger Station in both July and August, with 11 °F on 2 days in August 1960.

Longer seasons between freezes than those shown in table 6 can, in general, be expected at adjacent slope locations—in connection with nighttime inversions.

Relative Humidity

ANNUAL REGIME

The general annual course of afternoon relative humidity in the RNR area is indicated in figure 23, using adjacent airport data. The plotted May-September averages from lower canyon fire-weather stations follow a closely parallel course during at least this portion of the year. The numerical values of relative humidity tend to vary inversely with temperature (Schroeder and Buck 1970), and this accounts largely for the high values in winter, even though the "absolute humidity" (as indicated by the dewpoint temperature) is then lowest. (Monthly average dewpoint at Missoula, MT, for example, ranges from 15 °F in January to 45 °F in July.) Likewise, relative humidity generally averages lowest around midafternoon, but the afternoon values tend to increase with elevation (and lower temperature).

As estimated from figure 23, midafternoon relative humidity averages generally between 65 and 80 percent during December and January, depending on location. A late winter and early spring decrease brings April averages down to about 35 to 45 percent. Related to the late spring shower activity, only a slight further decrease, if any, occurs in the May and June humidity averages. This is followed by a pronounced decrease to annual minimum values in July and August—and the steep rising trend in autumn. July-August averages for early afternoon, to be shown in greater detail, range from about 25 percent in the lower canyons to 30 to 35 percent at 5,000- to 6,000-ft west-side locations and around 40 percent at lookouts near 8,000 ft; midafternoon values average several percentage units lower.

Nighttime relative humidity, which usually reaches a maximum value near dawn, shows greater areal variation than the afternoon averages—particularly in summer. The Boise and Missoula airport stations have 5 a.m. monthly averages of 77 to 81 percent and 85 to 87 percent, respectively, during November through February, but the averages diverge to 53 and 76 percent, respectively, in July. In the RNR, many of the valley and canyon locations with strong nighttime cooling apparently have early morning humidity averaging 90 percent or higher throughout the year. Much lower summer nighttime values typically occur at lookouts and slope locations, above the cool inversion layer.

TEMPERATURE AND RELATIVE HUMIDITY DURING THE FIRE SEASON

Averages and Frequencies of Afternoon Values—Figure 24 portrays, with 10-day detail, the average course of early afternoon temperature (dry bulb) and relative humidity during the fire season. The two sets of curves, averaged for the indicated station groupings, give a general though somewhat reduced range of numerical values for canyon and valley locations. Individual station details are given in table 25 (appendix). As mentioned at the beginning of this report, the 1964-83 period used here may not closely represent another 20-year period. Likewise, the averages, based on 1300 m.s.t. observations, do not quite represent the afternoon extreme conditions.

Table 6—Freezing temperature thresholds. Mean, median (Med.), earliest recorded, and latest recorded dates of last-spring and first-autumn occurrences of specified minimum temperatures (Min.), °F; season division taken as July 31. SD is standard deviation, days. Mean and median based on or adjusted (Adj.) to period 1951-80; extreme dates as observed during 1951-85, except as noted (Extr.). E denotes estimated (missing data); blank column, item not calculated

		Date of occurrence[1]										No. days interval	
		Last in spring					First in autumn						
Station	Min.	Mean	SD	Med.	Earliest	Latest	Mean	SD	Med.	Earliest	Latest	Mean	SD
Big Creek 1 S	32	7/25			7/17	7/31	8/ 5			8/ 1	8/ 9	11	
Adj.	28	7/ 9			6/ 3	7/31	8/18			8/ 1	9/13	40	
Extr. 1951-67	24	6/10			5/14	7/29	9/ 8			8/12	10/15	90	
Blackbird Mine	32	7/ 1					8/27					57	
Adj.	28	6/14					9/10					88	
	24	5/19					9/23					127	
Campbell's Fy.	32	5/ 9					10/ 2					146	
Adj.	28	4/22					10/18					179	
	24	3/27					11/ 2					220	
Cascade 1 NW	32	6/18	19	6/23	5/14	7/22	9/ 3	14	9/ 2	8/ 4	10/16	77	25
	28	5/30	18	5/29	4/25	7/ 8	9/13	14	9/12	8/28	10/26	106	26
	24	5/ 5	16	5/ 2	4/ 9	6/29	10/ 2	16	9/30	9/ 4	10/27	150	22
Challis	32	5/28	21	5/26	4/17	7/ 2	9/17	10	9/16	8/28	10/17	112	24
	28	5/13	16	5/12	4/16	6/26	10/ 1	11	9/30	9/13	10/27	141	19
	24	4/24	10	4/24	4/ 6	5/16	10/12	12	10/15	9/17	10/30	171	16
Cobalt	32	6/27			6/ 9	7/18	8/25			8/ 4	9/13	59	
Adj.	28	6/ 8			5/ 6	7/ 8	9/13			9/ 2	9/30	97	
Extr. 1966-85	24	5/14			4/13	5/31	9/23			9/ 2	10/ 9	132	
Deadwood Dam	32	7/18	11		6/29	7/31	8/15	12		8/ 1	9/11	28	18
Adj.	28	6/26	19		5/18	7/30	8/27	13		8/ 2	9/20	62	26
Extr. 1949-74	24	5/29	20		4/25	7/ 7	9/19	12		9/ 3	10/24	113	25
Dixie	32	7/24	9	7/28	6/29	7/31	8/ 6	5	8/ 4	8/ 1	8/29	13	11
	28	7/10	17	7/13	6/ 1	7/31	8/14	11	8/13	8/ 1	9/ 6	35	22
	24	6/ 5	22	5/31	5/ 1	7/29	9/ 6	11	9/ 4	8/12	10/ 2	93	28
Elk City	32	7/13	18	7/19	5/26	7/31	8/11	10	8/ 7	8/ 1	9/ 7	30	21
	28	6/13	27	6/ 4	5/ 1	7/29	9/ 2	18	9/ 1	8/ 1	10/17	81	38
	24	5/ 8	16	5/ 2	4/17	6/ 3	9/20	16	9/17	8/29	10/26	138	22
Gibbonsville	32	6/22			5/27	7/ 7	9/ 3			8/23	9/24	73	
Adj.	28	6/ 2			5/ 5	6/28	9/15			8/30	10/24	105	
Extr. 1966-79, 84-85	24	5/10			4/19	5/30	9/30			9/14	10/26	143	
McCall	32	6/22	17	6/28	5/16	7/22	8/26	14	8/28	8/ 1	9/22	65	26
	28	5/29	17	5/28	5/ 1	7/ 8	9/12	14	9/11	8/ 9	10/25	106	24
	24	5/ 8	16	5/ 5	4/13	6/26	10/ 1	17	9/30	9/ 2	11/ 6	145	25
Middle Fk Lodge	32	6/ 6			5/14E	7/ 8	9/11			8/23	10/ 3	97	
Adj.	28	5/12			4/13	6/ 8	9/26			9/ 2	10/27	137	
Extr. 1971-85	24	4/26			4/ 7	6/ 6	10/16			9/17	11/ 9E	173	
New Meadows	32	7/ 1	17	7/ 2	6/ 1	7/31	8/20	12	8/23	8/ 1	9/13	51	21
	28	6/ 5	21	5/30	4/29	7/29	9/ 7	10	9/ 7	8/17	9/30	96	23
	24	5/17	15	5/18	4/16	6/26	9/21	11	9/18	9/ 4	10/16	128	21
Riggins	32	4/22	17	4/21	3/16	5/31	10/21	15	10/24	9/15	11/22	182	21
	28	4/ 3	13	4/ 1	2/ 5	4/26	11/ 7	17	11/ 3	10/ 6	12/23	218	20
	24	3/ 4	26	3/12	1/ 7	4/14	11/24	20	11/21	10/13	1/12	265	35
Salmon 1 N	32	5/30	16	5/26	5/ 1	7/ 2	9/15	12	9/15	8/14	10/16	108	19
	28	5/11	16	5/12	4/15	7/ 2	9/25	12	9/22	8/28	10/24	137	22
	24	4/24	9	4/22	4/ 9	5/11	10/ 7	11	10/ 7	9/17	10/27	166	16
Shoup	32	5/19			4/15	6/ 4	9/26			9/14	10/23	130	
Adj.	28	4/30			4/ 8	5/16	10/ 6			9/18	10/30	159	
Extr. 1966-85	24	4/ 9			3/ 8	5/12	10/24			9/20	11/14	198	
Stibnite	32	7/ 7					8/21					45	
Adj.	28	6/18					9/ 7					81	
	24	6/ 3					9/28					117	
Warren	32	7/24	8	7/26	6/30	7/31	8/ 6	7	8/ 3	8/ 1	8/29	13	11
1960-85	28	7/11	14	7/12	6/10	7/31	8/14	11	8/ 3	8/ 1	8/29	34	19
	24	6/16	22	6/13	5/14	7/24	9/ 3	12	9/ 6	8/ 6	9/20	79	30
Yellow Pine 7 S	32	6/27			6/12	7/31	8/22			8/ 1	9/ 5	56	
Adj.	28	6/10			5/27	7/ 9	9/ 9			8/ 9	9/15	91	
Extr. 1970-85	24	5/13			4/18	6/27	9/27			9/ 8	10/ 3	137	

[1]Month number/day number; thus 5/14 is May 14.

The curves in figure 24 reveal an accelerated trend in late June toward the peak warm, dry conditions of July and August—corresponding with the seasonal decrease in precipitation (fig. 8). During late July-early August, the early afternoon temperatures average about 90 °F at some of the lower canyon locations (along the main Salmon River below 3,000 ft). Corresponding relative humidity averages near 25 percent over a larger canyon area (including portions of the Middle Fork Salmon and South Fork Salmon). The values portrayed in figure 24 may average 4 or 5 °F below the daily maximum temperatures and about 5 percent below the daily minimum relative humidity; this is indicated in table 7.

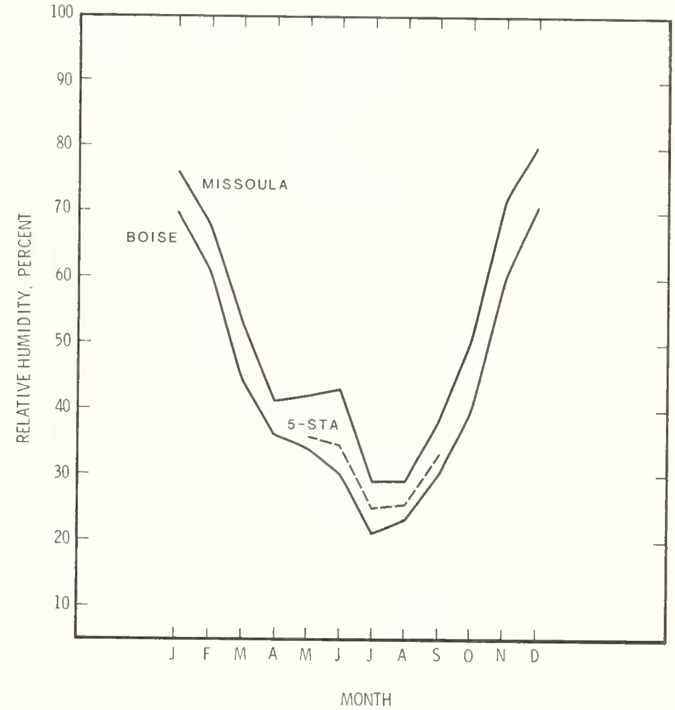

Figure 23—Monthly average relative humidity, percent, near 1700 m.s.t., at National Weather Service airport stations adjacent to RNR. Based on years 1940-81 at Boise, ID; 1945-81 at Missoula, MT. Dashed line shows humidity average for five lower canyon fire-weather stations in or near wilderness, at about 1300 m.s.t., based on available 1964-83 data; stations are at Riggins, Campbell's Ferry, Indianola, Krassell, and Little Creek.

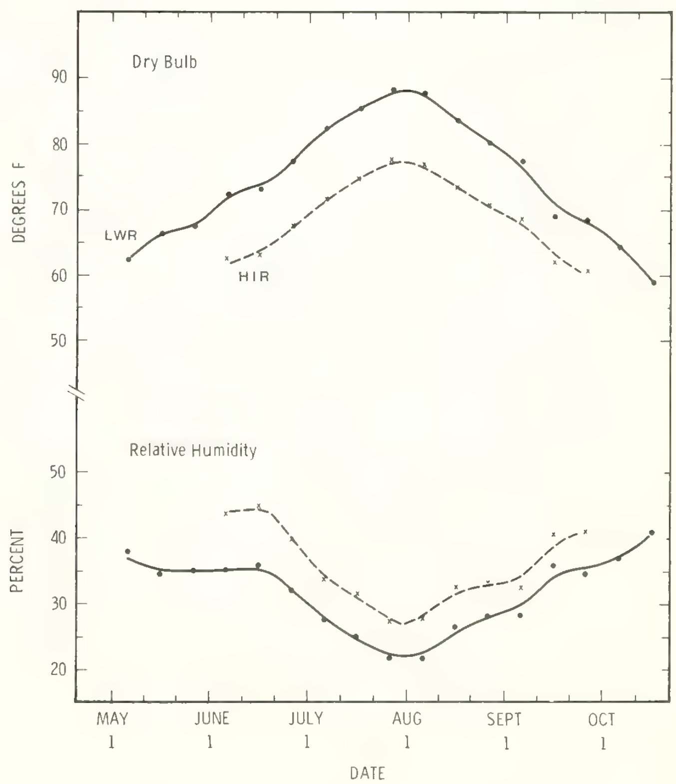

Figure 24—Ten-day average dry bulb temperature and relative humidity at afternoon fire-weather observation time, mostly near 1300 m.s.t., based on 1964-83. Dots, plotted at mid-points of 10 (or 11)-day periods, represent average for five lower canyon (LWR) stations; X symbols, average for four higher valley (HIR) stations (elevations 5,025 to 6,680 ft). Curves are drawn through smoothed values (except at end points), obtained by 1-4-1 weighting factor.

Table 7—Left: Average reported daily maximum and minimum relative humidity (RH), percent, at fire-weather stations,[1] July-August; based on available years during 1964-83. Min.-Ob. is difference between average minimum and corresponding average RH at afternoon observation time, mostly near 1300 m.s.t.[2] The 20-year, 1964-83, average minimum RH may be estimated by adding Min.-Ob. to Ob.20, which is the 20-year average at observation time. Right: July-August average daily maximum temperature, °F, during 1968-83 except as noted; based on 24 hours ending at afternoon observation time. Max.-DB is difference between average maximum and corresponding average dry bulb (DB) temperature

Station	July-August average RH, for years shown at left				July-August average temp., 1968-83	
	Max.	Min.	Min.-Ob.	Ob.20	Max.	Max.-DB
Bonanza 1972-83	89.1	26.2	−4.1	29.0	77.6	+4.4
Campbell's Ferry 1969-78	75.6	23.8	−2.9	[3]25.7	[4]92.4	+5.7
Cascade 1968-83	84.0	25.8	−4.2	29.4	82.0	+5.0
Challis 1969-83	62.4	20.1	−4.0	23.4	84.4	+4.7
Indianola 1968-83	88.8	25.4	−2.5	26.8	89.9	+6.4
Krassel 1973-83	91.2	18.1	−7.5	23.3	87.4	+4.9
Landmark 1968-81	92.0	25.6	−4.5	[3]30.2	75.8	+4.4
Little Creek 1975-83	82.5	23.6	−5.6	24.5	86.6	+5.4
McCall 1971-83	92.2	27.2	−7.2	33.0	80.3	+4.8
Red River 1964-83	95.9	32.8	−5.1	37.9	80.6	+5.4
Riggins 1964-83	64.0	23.0	−2.8	25.8	91.8	+5.4
Hell's Half Acre 1965-83	72.1	34.4	−8.9	43.4	68.8	+5.8

[1]Data from hygrothermographs of uncertain accuracy; calibration errors may compensate over a period of years.
[2]Observations near 1600 m.s.t. prior to 1974 at Campbell's Ferry, Red River, Riggins, and Hell's Half Acre; prior to late 1960's at other stations.
[3]Average from shorter period adjusted to 1964-83.
[4]For 1968-78.

The areal pattern of summertime (July-August) early afternoon temperature and humidity is depicted in figure 25. Some of the 20-year averages were calculated (using the previously mentioned "difference method") from only a few years of data and thus represent only a "best estimate." A tendency is shown—at various elevations—for higher average humidity toward the northern edge of the RNR area, where there is also somewhat greater July-August precipitation (fig. 6). Overall, the data from 38 stations (excluding outlying Elk City and Challis) show an average (regression-line) increase in relative humidity with elevation, at a rate of 2.3 percent per 1,000 ft (r, 0.83). Between neighboring canyon and lookout, the calculated humidity increase is closer to 3.0 percent per 1,000 ft. The overall temperature lapse rate, from all available stations in figure 25, is 3.9 °F per 1,000 ft, with r −0.97. These values are nearly identical to those obtained for July-August maximum temperature (fig. 22).

The frequencies of selected afternoon temperature and humidity values, or thresholds, are graphed in figure 26, again for two station groupings. Details for individual stations are presented in table 26 (appendix). The frequency curves tend to follow the seasonal pattern of average values (fig. 25)—inversely in the case of low relative humidity thresholds. The curves, like the average values, show a generally steepening trend beginning in late June.

With the previous caution regarding the 1964-83 period, the frequencies may be regarded as approximate climatic probabilities. Thus, the chance of early afternoon humidity below 15 percent, at an "average" lower canyon location (fig. 26), would hold steady at about 6 percent during mid-May through mid-June, rise to 30 percent or higher during late July-early August, and fall to 5 percent in late September. A smaller chance, peaking at about 12 percent, is indicated near 6,000 ft. The chance of early afternoon temperatures reaching 90 °F or higher would be 40 to 50

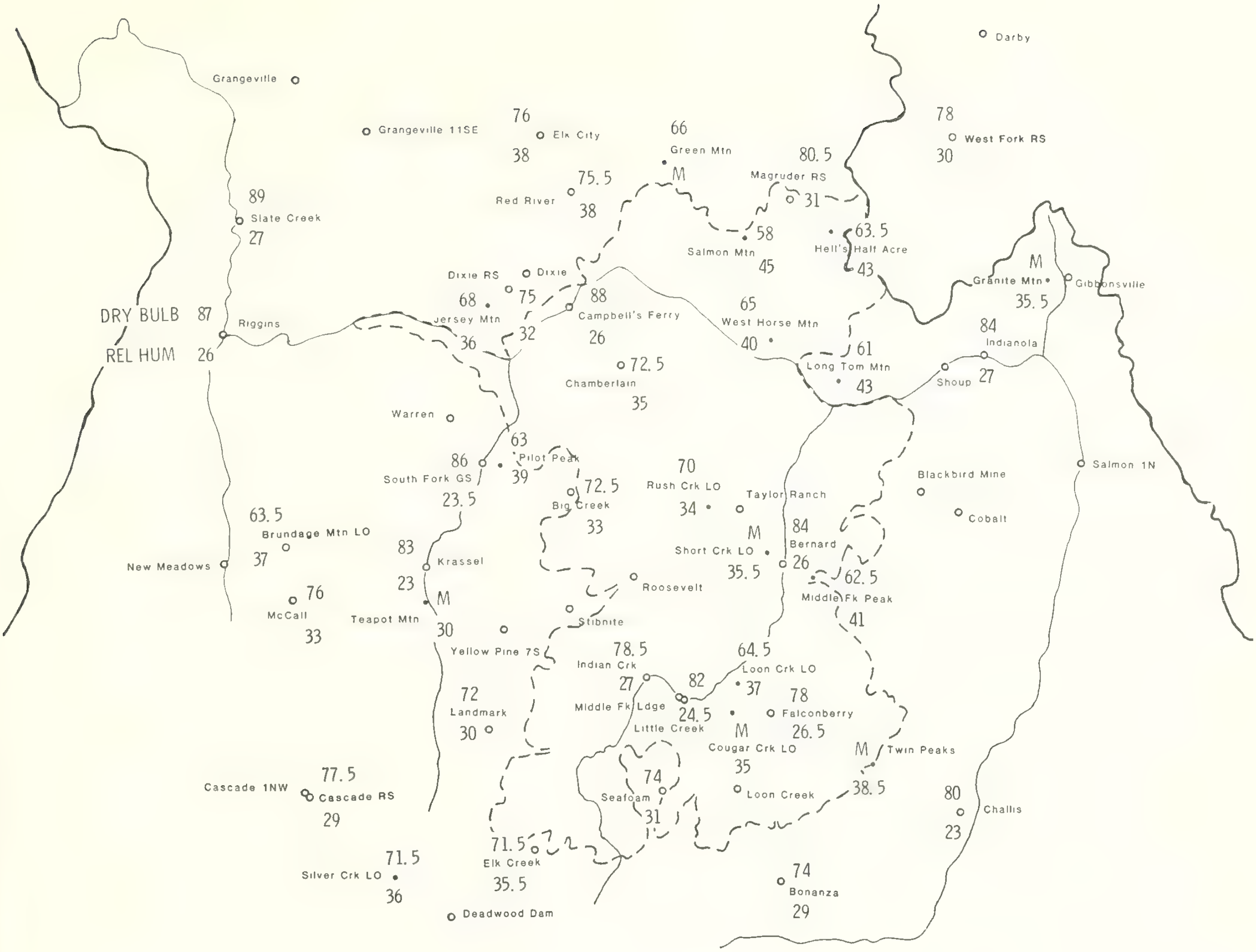

Figure 25—Average July-August dry bulb temperature (top number), °F, and relative humidity (bottom number), percent, at afternoon fire-weather observation time, now 1300 m.s.t. (see text). Based on or adjusted to 20 years 1964-83.

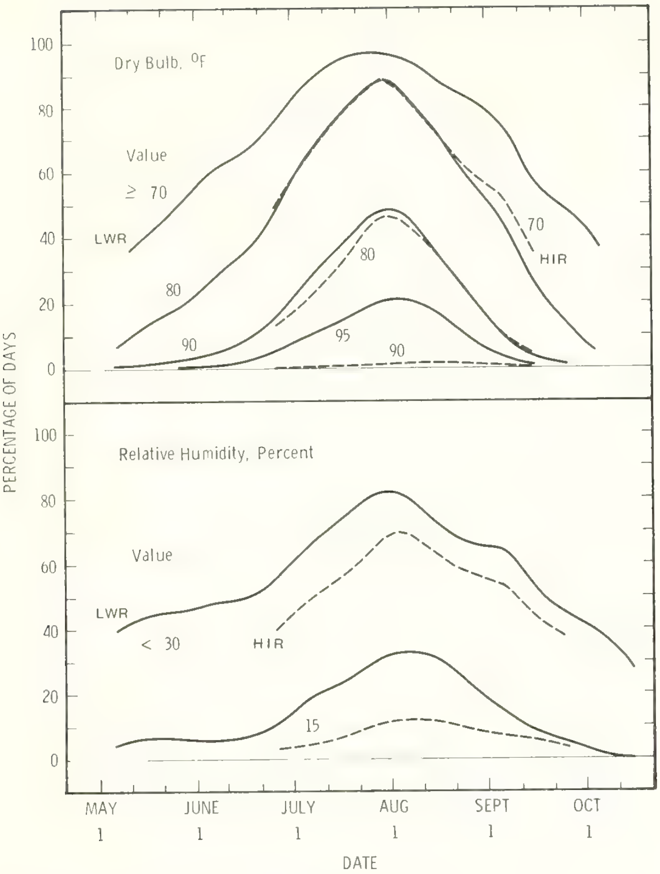

Figure 26—Percentage frequency of days with indicated dry bulb temperature and relative humidity values at afternoon fire-weather observation time, mostly near 1300 m.s.t., for period 1964-83; by 10 (or 11)-day periods. Curves, smoothed, for lower canyon (LWR) and higher valley (HIR) groupings of stations, as in figure 24.

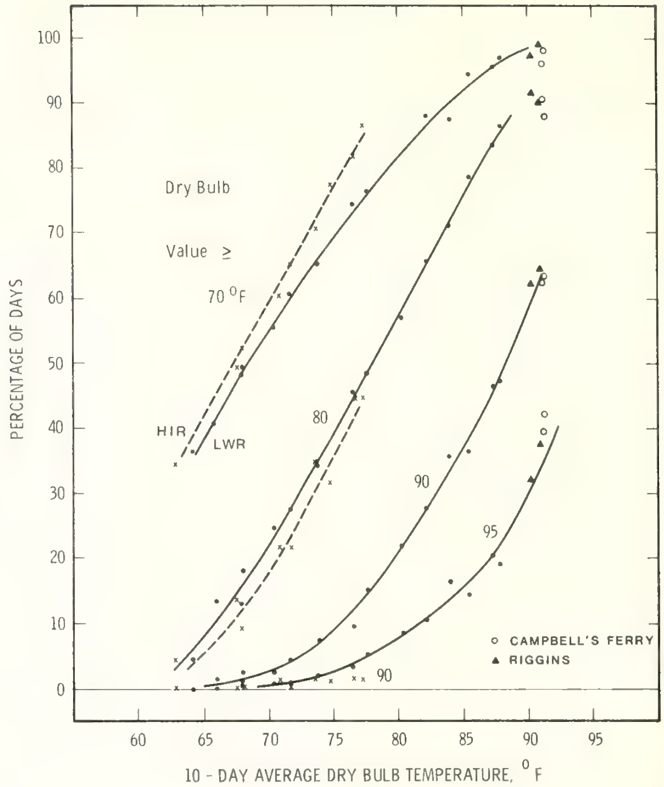

Figure 27—Relationship between 10 (or 11)-day average dry bulb temperature and percentage frequency of indicated values, during fire season; at afternoon observation time, mostly near 1300 m.s.t. Based on period 1964-83. Curves fitted by eye. For two groupings of stations as in figures 24 and 26; plotted points based on smoothed 10-day values. Data cover season May 11-October 10 at lower canyon stations; June 11-September 20 at higher valley stations. Additional points, unsmoothed values, are plotted for individual stations.

percent during part of July-August at locations near 3,000 ft (more than 60 percent at Campbell's Ferry and Riggins); 1 or 2 percent near 6,000 ft.

The above frequencies, and those of precipitation and thunderstorms, will vary greatly under differing weather-map patterns. In the neighboring Selway-Bitterroot Wilderness (Finklin 1983a), for example, with a dominating upper-air ridge, the 14-year frequency of July-August midafternoon humidity ≤30 percent was about 95 percent for two ranger stations. With an upper-air trough, the frequency was about 25 percent.

The relationship between frequencies and average values has been plotted for afternoon temperature in figure 27; for relative humidity in figure 28. The drawn curves may be used to estimate frequencies, or probabilities, elsewhere in the RNR (within elevational limits) during any portion of the fire season. Required input is the corresponding 10-day average value, observed or estimated, at an existing station or other location.

To illustrate use of figure 27, the required probability may be that of a 1300 m.s.t. dry bulb ≥80 °F during September 1-10 at a 3,000-ft location. From figure 24, the September 1-10 climatic average is estimated at 77 °F. Entering figure 27 (horizontal scale) at this value, a line is projected vertically until it intersects the "lower canyon" 80 °F curve. The probability (percentage of days), read by a horizontal line projection from this point, is 47 percent. Probability estimates for temperatures within a range, such as 80-89 °F, can be obtained as the percentage difference between probabilities read from the bracketing curves. In the above case, the result would be 34 percent—the 47 percent value obtained for a dry bulb ≥80 °F minus 13 percent for a dry bulb ≥90 °F.

Assuming the figure 27 relationships hold for other times of afternoon, probabilities of specified maximum temperatures (up to 95 °F) may be estimated. The horizontal scale is entered at the appropriate 10-day average maximum value (up to 92 °F), which may be approximated by adding 5 °F to the 1300 m.s.t. average dry bulb.

Analogous procedures are used for probability estimates pertaining to relative humidity (fig. 28).

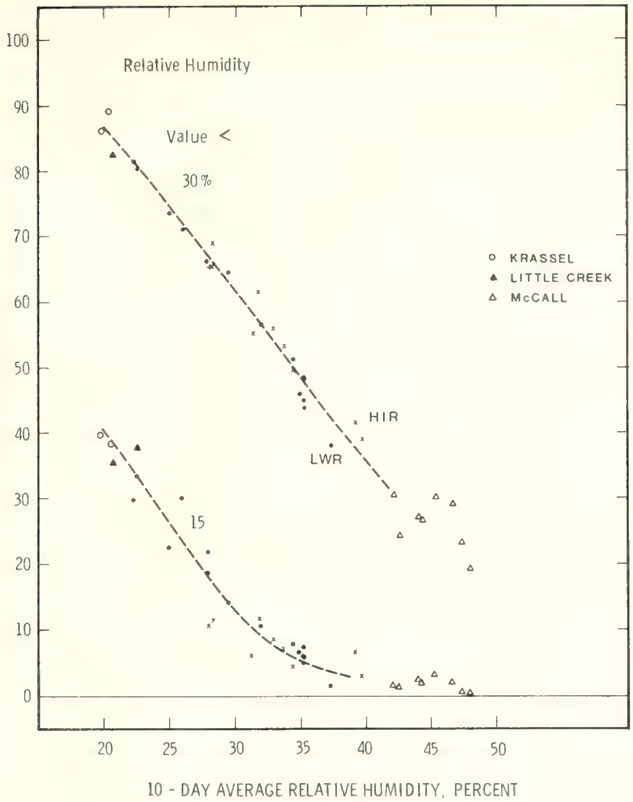

Figure 28—Relationship between 10 (or 11)-day average relative humidity and percentage frequency of indicated values, at afternoon observation time; as in figure 27.

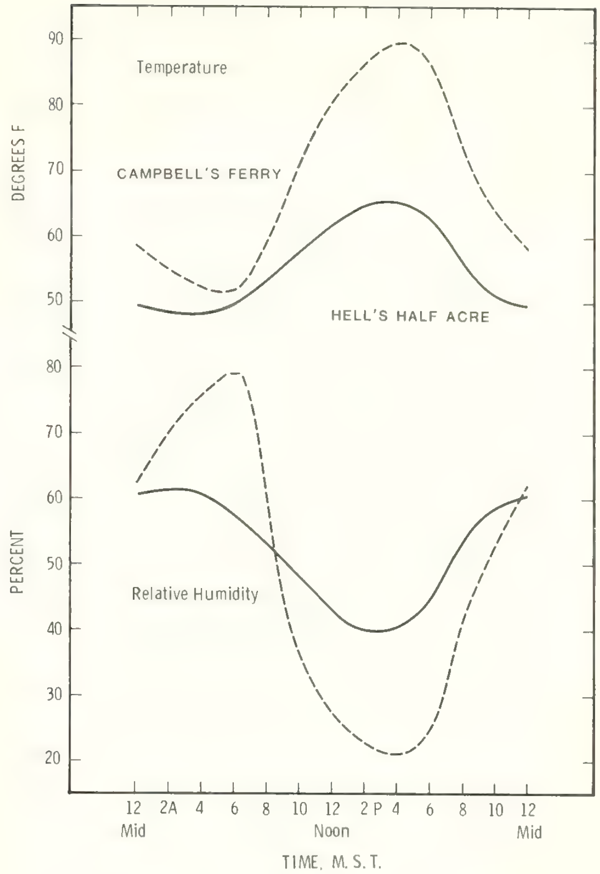

Figure 29—Average diurnal variaton of temperature and relative humidity during July at lower canyon and lookout locations; based on limited available data from hygrothermograph (see text). At Campbell's Ferry during 1971 and Hell's Half Acre during 1957 and 1961-62 (3-year average).

Diurnal Variation of Temperature and Relative Humidity—The general diurnal course of summertime temperature and relative humidity is depicted in figure 29 for two different types of location—lower canyon bottom and 8,000-ft lookout. Our choice of stations and months here was limited by the small file of past (Northern Region) hygrothermograph traces available at IFSL—particularly traces representing near-normal monthly conditions and having acceptable calibration accuracy for humidity.

The contrast seen in diurnal ranges illustrates previous comments about nighttime inversion effects and the inverse variation of relative humidity with temperature. Curves for some other canyon or valley locations would probably show average humidity values of 90 percent or higher near dawn (table 7), compared with the 79 percent value at Campbell's Ferry. Figure 29 indicates that the warmest, driest time of day in July is usually near 1500 to 1600 m.s.t. The previous fire-weather observation time, in effect before the late 1960's (Intermountain Region) or 1974 (Northern Region), thus tended to represent the afternoon extreme conditions. Temperatures in figure 29 show average rises of 2 to 5 °F at the lookout and canyon station, respectively, between the present fire-weather observation time (1300 m.s.t.) and 1600. The corresponding humidity decreases are about 2 percent. These 3-hour changes will vary somewhat with location.

Recent 10-year Anomaly—The 20-year period 1964-83, used (with little choice) as our primary base for fire-weather data, includes two contrasting successive 10-year periods. As shown in table 8, afternoon dry-bulb temperatures observed during July and August 1974-83 averaged generally 3 to 5 °F lower than those in 1964-73; relative humidity averaged about 5 to 10 percentage units higher. Where available, the June and September averages exhibit little change or even show an opposite tendency. The July and August 1974-83 averages are also noticeably different from those for 1951-70 (table 8), available only for Northern Region stations. This behavior has been found elsewhere in Idaho and Montana (Finklin 1986; Finklin and Fischer 1987).

Part of the 1974-83 anomaly could be explained by the 3-hour change in fire-weather observation time in 1974—judging from figure 29 and diurnal curves elsewhere (Finklin 1983c, 1986). Yet, the anomaly (or fluctuation) is also strong at Intermountain Region stations, where the present observation time was adopted relatively early in the 1964-73 period. The "real" anomaly component reflects a generally cooler, moister summer afternoon regime, apparently related to the greater summertime precipitation during recent years (table 15, appendix).

Table 8—Monthly fire-weather averages during 1974-83, at 1300 m.s.t., compared with averages during 1964-73[1] and with available 1951-70 data (differences in parentheses). DB is dry bulb temperature, °F; RH, relative humidity, percent; WS, windspeed, mi/h. Freq <20 is percentage of days with RH less than 20 percent

		1974-83, 1300 m.s.t.				Difference, 1974-83 minus 1964-73 (and 1951-70[2])			
Station	Month	DB	RH	WS	Freq <20	DB	RH	WS	Freq <20
Bonanza	July	73.2	32.0	6.5	29	−2.5	+5.9	+0.9	−11
	Aug.	71.3	30.7	5.3	29	−3.4	+3.7	−0.4	−11
Cascade	July	76.9	32.1	4.4	13	−2.8	+6.0	−0.9	−14
	Aug.	74.8	33.4	4.3	14	−3.5	+7.0	−1.6	−27
	Sept.	66.8	37.7	4.5	10	+1.3	+2.7	−1.2	−6
Challis	June	71.4	28.2	6.9	38	+0.8	−2.8	−0.2	+13
	July	80.4	24.1	6.6	48	−2.0	+3.1	−1.1	−9
	Aug.	77.2	26.0	5.2	43	−3.4	+3.7	−1.9	−15
	Sept.	68.7	27.2	4.4	38	+0.8	−0.2	−2.6	+5
Indianola	June	74.2	35.0	5.9	16	0.0	+2.1	−1.3	−8
	July	83.5	29.7	5.1	24	−3.4	+8.2	−2.6	−35
	Aug.	80.8	33.5	4.4	17	−4.2	+11.0	−2.4	−45
	Sept.	71.7	35.3	4.3	15	+1.7	+2.9	−1.9	−10
Krassel	July	81.3	26.1	6.8	44	−5.1	+6.6	−0.5	−23
	Aug.	79.2	26.8	7.1	43	−5.7	+5.8	+0.1	−22
Landmark	July	71.2	31.3	6.8	22	−2.9	+4.8	+0.3	−10
(1974-81)	Aug.	67.9	33.6	6.2	24	−5.0	+5.9	−0.8	−14
Little Creek	July	81.2	27.2	7.0	37	−4.0	+7.3	−3.2	−28
	Aug.	77.7	30.4	5.7	32	−5.5	+10.0	−4.8	−35
McCall	June	64.4	45.2	6.1	2	−1.6	+1.0	+0.9	−3
	July	74.7	35.6	5.5	7	−3.8	+6.1	−0.5	−15
	Aug.	73.1	37.0	5.4	16	−4.3	+7.4	−0.6	−17
	Sept.	65.5	40.9	4.8	9	+1.1	−0.9	−0.4	+2
Red River	July	74.1	41.8	4.3	5	−3.5	+7.4	−2.0	−12
						(−3.3)	(+6.3)	(−2.1)	(−8)
	Aug.	73.3	40.9	4.5	6	−3.8	+6.6	−2.1	−15
						(−2.0)	(+4.6)	(−2.1)	(−11)
Riggins	June	76.0	34.9	6.3	16	−0.8	−1.9	−1.8	+2
						(−1.0)	(−1.8)	(−1.4)	(+4)
	July	84.2	30.6	6.8	19	−5.4	+8.6	−1.8	−30
						(−5.0)	(+7.4)	(−2.8)	(−24)
	Aug.	84.4	28.9	6.0	29	−4.8	+7.1	−2.2	−31
						(−3.1)	(+5.3)	(−3.1)	(−23)
	Sept.	75.2	32.9	5.3	19	0.0	+2.6	−1.9	−8
						(−2.5)	(+3.7)	(−2.7)	(−12)
Hell's Half Acre	July	61.4	49.0	4.9	[3]16	−4.5	+9.3	−3.7	−18
						(−4.3)	(+7.8)	(−4.0)	(−17)
	Aug.	60.3	49.1	5.7	[3]15	−5.8	+13.7	−3.8	−40
						(−4.0)	(+8.3)	(−3.7)	(−28)

[1]Observations near 1600 m.s.t. at Red River, Riggins, and Hell's Half Acre; near 1600 m.s.t. prior to late 1960's at other stations.

[2]1954-70 at Hell's Half Acre.

[3]Frequencies at this station are for percentage of days with RH <30 percent.

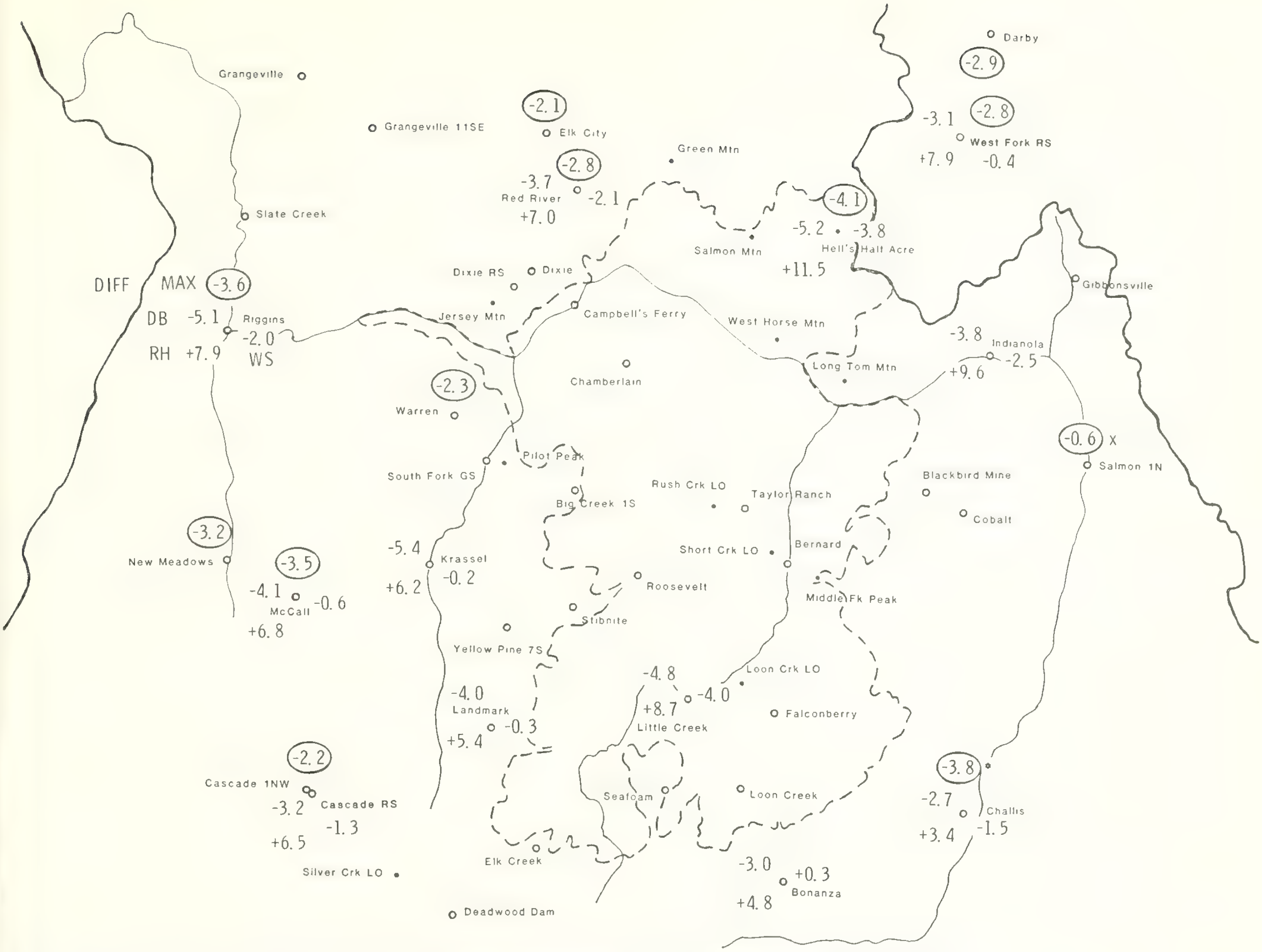

Figure 30—Differences in July-August, 1974-83 average values minus 1964-73 average values. For observed afternoon dry bulb temperature, °F (top number), and relative humidity, percent (bottom number), and for 24-hour maximum temperature, °F (number within oval). X-symbol (at Salmon) denotes station moved and daily observation time changed from midnight to 1700 m.s.t. in 1968. Asterisk (at Challis) denotes observation time changed from afternoon hour to 0800 in 1973.

The 10-year dry bulb and humidity changes, for July-August, are given an areal perspective in figure 30, together with the 10-year change in average daily maximum temperature. In the Intermountain Region, this change could be calculated only for the year-round climatic stations, since maximum temperature data were not included for this region in the National Fire-Weather Data Library archives until 1968 or 1969. The maximum-temperature changes in figure 30 indicate an actual climatic fluctuation of 2 or 3 °F in afternoon temperatures over the RNR area.

Relative to the 10-year changes in average maximum temperature, the changes in afternoon dry bulb (fig. 30) appear to be only 1 or 2 °F greater. This difference, if representing the effect of the fire-weather time change, is somewhat smaller than our previous indications.

Wind

ANNUAL PATTERN

Detailed wind data for the RNR area are limited to the fire season. On a larger scale, in the free atmosphere at 10,000 ft, wind flow across central Idaho is from an average westerly direction throughout the year, backing to west-southwesterly in summer (Finklin 1986). This wind is normally strongest in winter, lightest in summer. In the Selway-Bitterroot Wilderness area to the north, average windspeeds observed atop 9,350-ft St. Mary Peak, MT, were about 15 to 20 mi/h in winter months (Arno 1970). Because of modifications by local terrain, actual winds occurring at RNR locations may not closely follow the broad pattern.

Sheltered valley and canyon areas in Idaho-western Montana tend to have their lowest average windspeeds in autumn-winter, around 5 mi/h, and highest average speeds in spring (Finklin 1983a). Within the RNR, this appears to be the experience at Taylor Ranch (James J. Akenson 1987), though gusty winds near 15 mi/h do occur here in winter with a Pacific frontal passage. To the west at Riggins, as previously mentioned, winds during winter are often strong. Some canyon areas may have their highest afternoon winds in summer, associated with daytime heating and with thunderstorms. Squally periods are also reported, at Taylor Ranch, in spring and late autumn.

Wind directions are influenced by obstructing terrain and valley or canyon orientation (and may vary with time of day, discussed later). As reported at climatic stations prior to 1949, prevailing winds are from the southwest throughout the year at McCall, mostly northwest at Cascade, and west at Challis. At Riggins, the prevailing direction is from the south in winter and from the north in summer.

WIND DURING THE FIRE SEASON

Summer afternoon wind conditions are portrayed in figure 31. Effects of topography on prevailing directions are strongly evident. These directions are mostly west or southwest at the lookouts but represent all quarters of the compass at canyon locations. In addition to forced channeling of wind flow in the canyons, there is indication of a daytime upcanyon wind, described by Schroeder and Buck (1970). Thus, prevailing winds are from a northerly quarter at Bernard, Magruder, and Riggins. Southerly winds at Big Creek, Krassel, South Fork, and Little Creek, however, are from a downcanyon direction, indicating domination by the channeled larger scale (westerly or southwesterly) wind flow.

The early or middle afternoon windspeeds generally average between 6 and 8 mi/h in the canyons and valleys; up to 10 to 13 mi/h at some of the lookouts.

As with the July-August afternoon temperature and relative humidity values, the portrayed 1964-83 windspeeds may be affected by the change to a 1300 m.s.t.

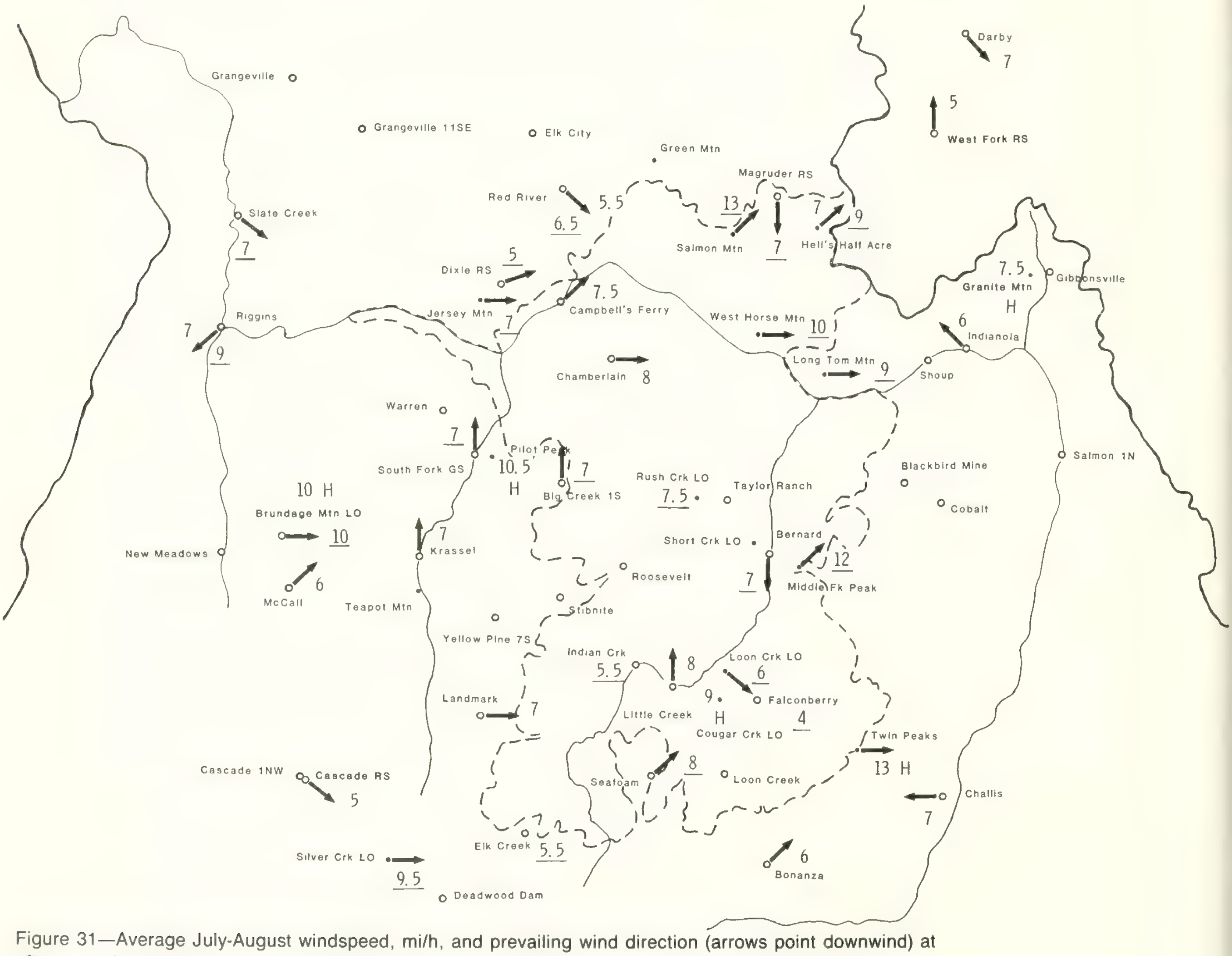

Figure 31—Average July-August windspeed, mi/h, and prevailing wind direction (arrows point downwind) at afternoon observation time. For period 1964-83, mostly near 1300 m.s.t., where available (for 1974-83 at Chamberlain). Earlier data, based on years prior to 1974, shown by underlined numbers (for period 1951-70 at Red River, Riggins, and Hell's Half Acre; observations near 1600 m.s.t.). H, at lookouts, denotes 24-hour average speed (1930's data).

fire-weather observation time, in addition to an anomalous 1974-83 regime. The 1951-70, 1600 m.s.t., averages included in figure 31 at three Northern Region stations are 1 or 2 mi/h higher than those for 1964-83. Ten-year comparisons (table 8) show that the lower 1964-83 averages in the Northern Region are due to 1974-83 decreases of 2 to 4 mi/h relative to 1964-73. Only a small 10-year change occurred at some of the Intermountain Region stations, but the July-August 1974-83 average at Little Creek exhibits a 4-mi/h decrease; the decrease here was 2 mi/h in June and September. Overall, the actual differences in July-August windspeed between early and middle afternoon may range from 0 to 2 mi/h.

Observed frequencies of afternoon wind directions and speeds at individual stations are given in table 27 (appendix). The speeds represent mostly a 10-minute average at the observation time. Frequencies of various windspeed, temperature, and humidity combinations are given in table 28 (appendix). Use of this three-way format will require summation to obtain frequencies for broader ranges of values and for values above or below certain thresholds.

Frequencies of higher windspeeds may be estimated from the relationship with average speed shown in figure 32. The data points, plotted individually for 23 stations, are derived from tables 27 and 28 (appendix). A station with summer afternoon windspeeds averaging 6 mi/h, at the daily observation time, has 10-minute speeds ⩾10 mi/h on about 15 percent of the days; ⩾20 mi/h on 0 to 1 percent. Where the average speed is 12 mi/h, the frequency of speeds ⩾20 mi/h may reach 10 percent. These frequencies should be greater for shorter duration speeds and for maximum sustained winds that may occur at any time of day. Crosby and Chandler (1966) found, at Salem, MO, that the probable maximum 1-minute average speed was generally 4 or 5 mi/h higher than the standard 10-minute average.

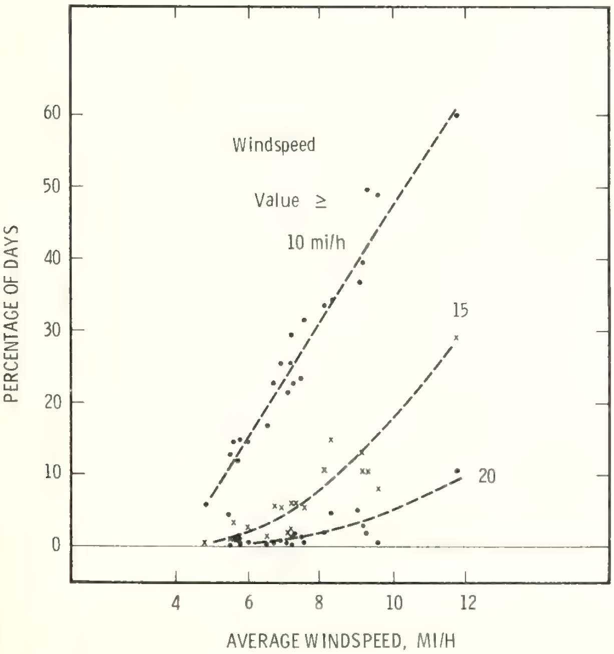

Figure 32—Relationship between average windspeed and frequency of observed higher windspeeds (10-minute averages), at afternoon fire-weather observation time. Curves fitted by eye. Points represent data for individual stations in or near RNR. For July and August combined, based on 1964-83 and shorter or earlier periods of available record.

Extreme Windspeeds—Table 27 (appendix) suggests that sustained strong winds (⩾25 mi/h) are generally rare during the fire season. Available once-daily observations show maximum July-August frequencies of 3 to 4 percent atop Middle Fork Peak and 4 to 5 percent atop Salmon Mountain (1931-53 data). Highest recorded 10-minute speeds, in the 1964-83 fire-weather data, are about 25 to 30 mi/h at canyon locations and 30 to 35 mi/h at lookouts. Lower extreme speeds, below 20 or 25 mi/h, are noted at high valley locations such as McCall, Landmark, and Bonanza. The timing of such extreme events can, of course, be of great importance in the case of wildfire. The extreme windspeeds have occurred with cool and showery conditions, but more often with warm and dry weather.

In the canyon bottom, Campbell's Ferry reported 33 mi/h, from the southwest, in June 1966, on a cool showery day. Speeds of 36 to 37 mi/h were recorded atop Long Tom Mountain and Middle Fork Peak in early September 1969, with fair, cool weather. Earlier data from Salmon Mountain show an afternoon wind of 43 mi/h in August 1953; 42 mi/h on a fair, warm day in August 1945.

On Saint Mary Peak, however, Arno (1970) reports a 1-hour average speed of 60 mi/h on a July day in 1968, associated with thunderstorm activity. Peak gusts reached about 90 mi/h.

Diurnal Variation of Wind—Fire-season windspeeds in the canyons and valleys should average highest in midafternoon and lowest during the nighttime and early morning hours. This pattern is indicated in the neighboring Selway-Bitterroot Wilderness, where fire-season morning wind data were available (Finklin 1983a), and at adjacent airport weather stations. Near-calm nighttime conditions are indicated at many bottom locations by the strong nighttime cooling (fig. 20), which is related to undisturbed temperature inversions. Nighttime winds may exhibit a reversal in direction—with predominating downslope and downcanyon air movement (or "drainage winds") (Schroeder and Buck 1970). Winds in bottom areas, however slight, would be generally from the south or east.

Winds on some of the openly exposed ridgetop or mountaintop terrain may often increase during the nighttime hours (Baughman 1981). By morning (0900 m.s.t.), however, July-August average speeds atop Hell's Half Acre and Salmon Mountain (Finklin 1983a) were 2 or 3 mi/h lower than those in midafternoon. Nighttime wind directions at such locations tend to change little, remaining generally from the west or southwest.

Nighttime windspeed maximums were observed at two lookouts in southern Idaho (Hanna 1933)—at Bald Mountain and Shafer Butte, near Boise; but not at Brundage Mountain, near McCall. The average diurnal windspeed curves (reproduced in fig. 33) show some marked diversity, indicating local topographic influences that may also apply to the RNR area.

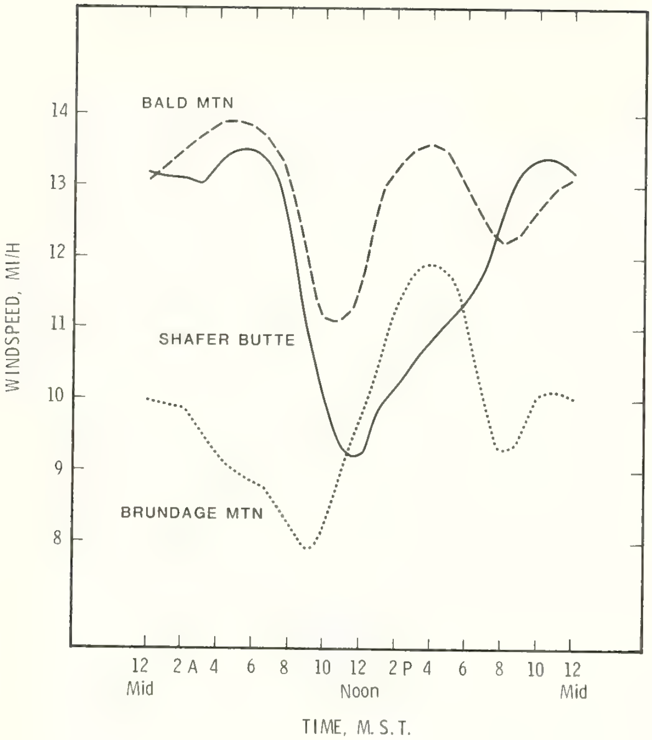

Figure 33—Average diurnal windspeed variation at three lookouts in southern or central Idaho. Based on 4 or 5 years, July-September 1928-32. (From Hanna 1933.)

Persistence of Weather

A tendency for persistence of weather patterns during the course of a year or fire season could aid in planning for fire management and other activities. Such persistence is examined here, utilizing temperature and precipitation data from McCall, a station with a suitably long record. The primary results are in terms of frequencies or probabilities. As with more elaborate methods of long-range forecasting, monthly or seasonal outlooks based on persistence give only the gross outcomes relative to normal conditions; important details, covering smaller time scales, may be obscured.

For our temperature index, average daily maximum, rather than the mean (of the maximum and minimum), has been chosen as better relating to the clear, dry (or cloudy, moist) character of a month or season. Correlations, based on 55 years, indicated very little persistence in successive monthly temperature regimes. The coefficient, r, was 0.03 between May and June average maximums, 0.21 between June and July, and 0.12 to 0.05 for the remaining pairs of months through October. A correlation between 2-month averages, representing late spring (May-June) and summer (July-August), was, however, statistically significant at the 1 percent level (Freese 1967; Snedecor 1956), with r 0.51. (A similar tendency was found in northwestern Montana [Finklin 1986].) Persistence between these two seasons is thus explored in table 9.

Table 9—Frequency of specified maximum-temperature classes[1] in summer (July-August) following those in spring (May-June); at McCall, ID, based on 55 years 1931-85. For each combination of May-June and July-August classes, listed top number is the actual number of cases; bottom number is the percentage of all cases in the corresponding row

May-June max. temp. class	July-August max. temp. class: Below normal	Near normal	Above normal	Total cases	Chi-square test value
	- - - - Number of cases - - - -				
Below normal	8	9	2	19	
	Percent of total in row				
	42	47	11		
Near normal	8	8	3	19	
	42	42	16		
Above normal	1	5	11	17	
	6	29	65		
Total	17	22	16	55	[2]13.20

[1]Criteria are based on standard deviation (SD) about the 55-year average maximum value; observed SD was 3.0 °F for May-June and 2.5 °F for July-August. "Above normal" class is defined by temperature >0.5 SD from average; "below normal," <−0.5 SD from average.
[2]Statistically significant; P (probability of a greater value) = 0.01.

Table 10—Frequency of specified precipitation classes[1] in summer (July-August) following those in spring (May-June); at McCall, ID, based on 55 years 1931-85. Numbers listed as in table 9

	July-August precipitation class				
May-June precip. class	Below normal	Near normal	Above normal	Total cases	Chi-square test value
	- - - - - - Number of cases - - - - - -				
Below normal	7	7	5	19	
	Percent of total in row				
	37	37	26		
Near normal	6	8	6	20	
	30	40	30		
Above normal	7	4	5	16	
	44	25	31		
Total cases	20	19	16	55	[2]1.17

[1]Criteria are based on percentage of 55-year average 2-month precipitation totals and also consider the median totals and variability. Defined "near normal" limits are 75-120 percent for May-June; 65-120 percent for July-August.

[2]Highly insignificant; P (probability of a greater value) is almost 0.90.

In table 9, a defined warmer than normal May-June, occurring in 17 out of 55 years, was followed by a warmer than normal July-August in 65 percent of the cases; a cool July-August in but 6 percent. A converse tendency is indicated following a cooler than normal May-June. A chi-square test (above references), applied to table 9, shows statistically significant persistence (P, 0.01).

No such correlation or persistence was found between the May-June and July-August precipitation at McCall; r was 0.00 and the chi-square P value was almost 0.90. The lack of any useful result is shown in table 10.

Climatic Trends

Precipitation and temperature trends or fluctuations during about the past 60 years are portrayed in figures 34 and 35, respectively, using successive 5-year annual and seasonal (2-month) averages. The precipitation values are converted to percentages of the 1951-80 normals. Mean temperatures are converted to degree departures from normal.

Annual-precipitation indications from McCall, Challis-Salmon (two-station average), and streamflow measurements all show the historically well known dry period covering much of the 1920's and 1930's. The low point occurred during 1931-35, with the 5-year averages about 70 to 75 percent of the present normal. A recovery to near or slightly above normal followed at the precipitation stations by 1941-45, but this was not attained by the streamflow until 1946-50. Relatively small 5-year fluctuations have occurred at McCall since the 1940's, with little overall trend; some difference in pattern is indicated in the dry Challis-Salmon area. In comparison, fluctuations in streamflow (runoff) have been rather wide since 1965. Successive 5-year averages have alternated from about 90 percent to 115 percent to 85 percent to 110 percent of normal.

The differences seen among the annual graphs may be attributed to both small-scale and larger scale areal variations in precipitation. The temporal fluctuations will truly differ across the RNR area, but the individual precipitation stations (limited here by suitable length of record) represent only sampling points in their respective, smaller areas. The annual runoff amounts, of course, integrate the precipitation received over a larger area, but these amounts also vary with the evapotranspiration and possible changes in ground water storage (generally small).

The seasonal precipitation graphs exhibit some opposing fluctuations but generally share in the extremely dry 1931-35 conditions. A notable feature is the relatively high July-August rainfall during the most recent 10 years (the pentads including 1976-85), reaching about 180 percent of normal at McCall during 1976-80. (See also table 15, appendix.) Averages were only 35 percent of normal during 1931-35 and 48 percent during 1966-70. The recent summer upturn has been found also in the northern Idaho area (Finklin 1983a, 1983c; Finklin and Fischer 1987).

Mean annual temperatures (fig. 35) at our reference stations were near or slightly below the present normal during the dry 1920's and 1930's, largely due to well-below-normal winter (December-February) temperatures. Corresponding May through October temperatures, overall, were about 1 °F above normal. The annual means show a relatively cool period during the 1940's to mid-1950's, about 1 °F below the present normal, followed by a warm peak during 1966-70, 1 °F above normal. The most recent 5-year fluctuation went below normal. A slight overall warming trend may be discerned since the 1920's. The trend since the 1910's would probably be more noticeable (as was found in northern Idaho; above references).

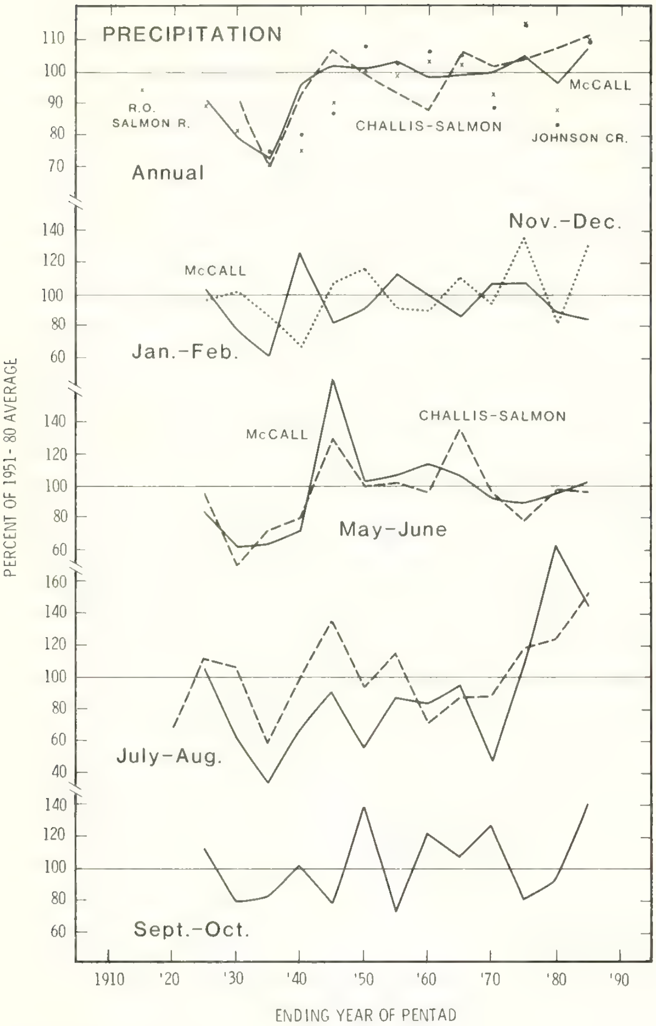

Figure 34—Fluctuations of annual and seasonal precipitation since 1920's at climatic stations adjacent to RNR. Shown by successive 5-year (pentad) averages for periods from 1920's through 1981-85, plotted at ending years of periods; graphs for McCall and Challis-Salmon two-station average. Values are given in percentages of 30-year, 1951-80, average precipitation. Note wider vertical scale used for annual percentages. Corresponding averages of water-year (October-September) runoff are shown, since 1910's, for Salmon River at White Bird (1916-20 data incomplete) and, since 1930, for Johnson Creek at Yellow Pine.

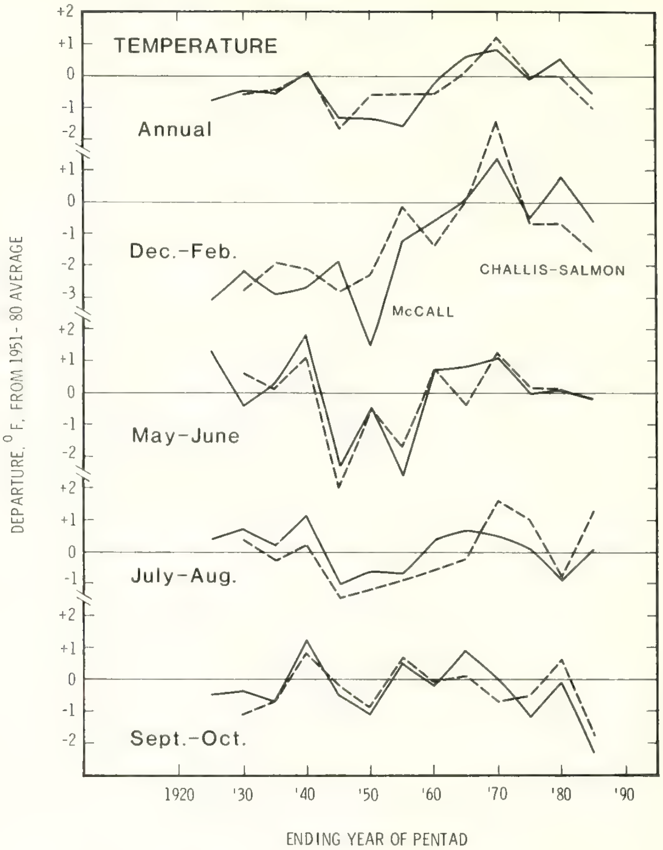

Figure 35—Fluctuations of annual and seasonal mean temperatures since 1920's at stations adjacent to RNR, shown as in figure 34 by successive 5-year (pentad) averages. Values, based on arithmetic averages of maximum and minimum temperatures, are given as departures, °F, from 30-year, 1951-80, averages.

As with precipitation, the seasonal mean temperatures exhibit some opposing fluctuations. December-February means since the 1960's have been about 2 to 3 °F above those of the 1920's to 1940's. July-August means show little overall change since the 1920's but, again, would probably be up from those of the 1910's and earlier.

The generally compensating ups and downs of temperature shown in figure 35 may be upset drastically in the future by an increasing carbon dioxide (CO_2) "greenhouse effect" (National Research Council 1983). According to most recent scientific consensus (Kerr 1986), a doubling of atmospheric CO_2, and increases of other gases, could raise average temperatures by at least 5 °F sometime during the next century.

SUMMARY

As shown by the various data, the Frank Church-River of No Return Wilderness area has climatic characteristics related to its geographic location in central Idaho and to its complex mountainous terrain. The broader climatic controls result in generally similar or parallel annual regimes of individual climatic elements across the wilderness.

Thus, except in some dry canyon locations, December and January are normally the wettest (or snowiest) months—favored by the large-scale upper-air flow and associated tracks of weather systems from the Pacific. The precipitation is enhanced particularly in the western RNR area by terrain-enforced uplift of the moist airmasses. Resulting average annual precipitation locally exceeds 60 inches but decreases to 15 inches in "rain shadow" canyon bottoms. Conditions normally are dry throughout the area in July and August, the main fire-danger months, indicated by both low precipitation amounts and low after-

noon relative humidity. Summer conditions appear somewhat drier than those farther north in Idaho, including the adjoining Selway-Bitterroot Wilderness.

Various tables of averages and frequencies are presented in the appendix to aid in fire-management planning. Station locations and lengths of available fire-weather records are limited, but the patterns revealed may be sufficient for many uses. Numerical values for other locations may be estimated or interpolated from general topographic and statistical relationships that have been described or shown in graphs.

For more site-specific data needs, the available averages can serve as a starting point from which local differences may be determined by field observations. The local effects on temperature, humidity, and wind should be at a maximum during fair, quiet weather. A promising future source of data for this area, where permissible, is the Remote Automatic Weather Station (RAWS) now employed in neighboring areas by the Forest Service and other agencies.

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APPENDIX: TABLES 11-28

Table 11—Index of stations used in this report, in RNR (Frank Church-River of No Return Wilderness) and adjacent area; listing by station types. Stations are in Idaho except as noted in Montana. Letter w following elevation (elev.) (ft) denotes location within wilderness or within 1 mile of boundary

Climatological Stations; data published by U.S. Weather Bureau and successor agencies

Station name	Elev.	Period of record[1]	Relocations,[2] year and distance (mi)	Comments
Big Creek 1 S	5,686w	1951-69	1965, 0.5; 1966, 1	Much missing data 1968-69. Station at Big Creek 1937-46, 49-50; not used.
Blackbird Mine	6,825	1948-60	1951, <0.1	Known as Forney Blackbird Mine to 1951; Cobalt Blackbird Mine thereafter.
Campbell's Ferry	2,310w	1976-85		Also see fire-weather station listing.
Cascade 1 NW	4,896	1942-	1948, 1; 1968 and 1969, <0.1	
Challis	5,175	1914-	1960, <0.1	Also see fire-weather station listing.
Cobalt	5,010	1962-	1964, <0.1; 1966, 0.2	
Council	2,950	1911-	1915, 0.1; 1942 and 1951, 1; 1953, 0.5; 1958, 0.1; 1968, 0.4	Station 1 or 2 mi NE of Council to 1953; briefly relocated 1.7 mi NE during 1960.
Cuprum	4,276	1916-32		No data 1927-29.
Darby, MT	3,880	1926-	1932, 1; 1957, 2	Station at 4,200 ft 1926-32. Also see fire-weather station listing.
Deadwood Dam	5,375	1930-74	1941, unknown	Known as Deadwood prior to Sept. 1941.
Dixie	5,620	1952-		Much missing data after 1981.
Elk City	4,058	1951-	1959, 0.2; 1960, 0.3; 1961, <0.1	Much missing data to 1958. Also see fire-weather station listing.
Gibbonsville	4,480	1963-	1965, 1	No data 1980-82.
Grangeville	3,355	1922-	1927, 0.6; 1939 and 1946, 1; 1949, 2; 1955 and 1969, 3/4	Elevations range from 3,323 to 3,409 ft.
Grangeville 11 SE	2,250	1965-		Much missing data 1983-84.
Landore	5,330	1904-15		
Loon Creek	5,810w	1909-26		Much missing data in some years.
McCall	5,025	1916-		Earlier station 1905-10. Also see fire-weather station listing.
Middle Fork Lodge	4,480w	1971-		
New Meadows	3,870	1913-	1941 and 1957, <0.1	Station at Meadows 1903-10.
Riggins	1,800	1930-	1957, <0.1; 1959 and 1973, unk; 1980, 0.6	Temperature record begins in 1937. Station closed much of 1979-80.
Roosevelt	7,500w	1902-08		
Salmon-Salmon 1 N	3,940	1906-	1911, 1912, 1919, 1937, and 1943, <0.5; 1968, 1	Salmon 1 N beginning 1968.
Shoup	3,400	1966-		
Slate Creek	1,568	1961-71		Also see fire-weather station listing.
Stibnite	6,550	1949-58		
Taylor Ranch	3,835w	1974-77, 83-		
Warren	5,907	1959-		Earlier records 1895-98 and 1923-31.
Yellow Pine 7 S	5,070	1970-	1972, 4.5	Station moved north to Yellow Pine in December 1986.

(con.)

Table 11 (Con.)

Fire-weather stations

Station name[3]	Elev.	Forest[4]	Period of record[5]
Bernard	3,700w	Salmon	[6]<1958-72
Big Creek RS	5,750w	Payette	<1932-72
Bonanza GS	6,376	Challis	1964-
Brundage Mtn LO	7,552	Payette	[7]1928-60 +
Campbell's Ferry	2,310w	Nez Perce	1960-78
Cascade RS	4,747	Boise	<1932-83
Challis	5,175	Challis	1934-
Chamberlain GS	5,745w	Nez Perce	1974-
Cougar Creek LO	8,100w	Challis	1937-38 +
Darby RS, MT	3,880	Bitterroot	1948-
Dixie RS	5,200	Nez Perce	1937-67
Elk City RS	4,058	Nez Perce	1959-70
Elk Creek RS	6,426w	Boise	<1964-71
Falconberry GS	4,808w	Challis	<1953-58
Granite Mtn LO	6,354	Salmon	<1932-38 +
Green Mtn LO	7,150	Nez Perce	1961-70
Hell's Half Acre LO	8,117	Bitterroot	1954-
Indian Creek GS	4,662w	Boise	1959-60 +
Indianola RS	3,450	Salmon	<1953-
Jersey Mtn LO	6,867	Nez Perce	1959-70
Krassel RS	3,600	Payette	1960-
Landmark RS	6,680	Boise	<1932-81
Little Creek GS	4,400w	Challis	1958-
Long Tom Mtn LO	8,168w	Salmon	1958-74
Loon Creek LO	8,364w	Challis	1965-71
Magruder RS	4,118w	Bitterroot	1961, 64-72
McCall SO	5,025	Payette	<1932-
Middle Fork Peak LO	9,127w	Salmon	1966-74
Pilot Peak LO	8,060	Payette	<1932-60 +
Red River RS	4,300	Nez Perce	1935-
Riggins RS	1,800	Nez Perce	1944-85
Rush Creek LO	6,810w	Payette	1965-71
Salmon Mtn LO	8,955w	Bitterroot	1929-53
Seafoam GS	6,200w	Challis	1965-71
Short Creek LO	7,861w	Salmon	<1932-38 +
Silver Creek LO	6,778	Boise	1965-71
Slate Creek RS	1,568	Nez Perce	1959-71, 86-
South Fork GS	2,900	Payette	<1932-59
Teapot Mtn LO	5,500	Payette	<1932-38 +
Twin Peaks LO	10,340w	Challis	<1932-35
West Fork RS, MT	4,370	Bitterroot	1961-
West Horse Creek LO	7,398w	Salmon	<1932-55

Table 11 (Con.)

Storage precipitation gages, recording precipitation gages, snow survey courses, and SNOTEL (snow telemetry) stations[8]

ID[9]	Station name	Elev.	Station[10] type	Period of record
BAN	Banner Summit	7,040	SN	1979-
BDC	Boulder Creek	5,440	SC	1938-
BGC	Big Creek Summit	6,580	SN	1936-
BKN	Burnt Knob	6,400w	PSz[11]	1967-83
BNZ	Bonanza	6,420	PS	1966-76
BRG	Brundage Mtn	7,560	SC	1965-
BRM	Bruce Meadows	6,390w	PS	1966-76
CRW	Crawford GS	4,860	SC	1936-
DWA	Deadwood Airstrip[12]	5,360	SC	1958-
DWS	Deadwood Summit	6,860	PS	1947-76
			SN	1936-
GRF	Greenfield Flat	7,370	SC	1961-73
GWS	Game Warden Saddle	6,300	PSz	1974-83
HDC	Hard Creek	7,100	PS	1967-73
JDC	John Day Creek	2,520	PSz	1976-
KIT	Kit Carson Pasture	4,950w	SC	1937-
LFK	Lake Fork	5,290	SC	1936-
LHR	Lower Hungry Ridge	4,400	PSz	1975-83
LMK	Landmark	6,680	PS	1947-50
MCA	Mica Ridge	6,800	SC	1962-73
MGC	Morgan Creek Summit	7,600	SN	1963-
MLC	Mill Creek Summit	8,794	PS	1966-76
			SN	1937-
MSC	Moose Creek	6,200	SC	1937-
MSP	Mullin Spring	4,900	PSz	1972-83
MTM	Mountain Meadows	6,360	PSz	1964-80
			SN	1965-
NUT	Nut Basin Ridge	7,400	PSz	1973-
NZP	Nez Perce Pass	6,575w	PS	1947-76
			SC	1937-
	Pittsburg Landing	1,400	PRz	1972-
PLC	Placer Creek	5,860	SC	1938-
PNG	Pungo Creek	4,800w	PS	1950-59
PRM	Perreau Meadows	8,500	SC	1979-
PSD	Pittsburg Saddle	4,200	PSz	1972-
	Rapid R. Fish Hatchery	2,100	PRz	1972-
	Red River RS	4,300	PRz	1964-80
RDR	Reed Ranch	4,100	PS	1967-76
RKF	Rock Flat Summit	5,310	SC	1946-
SAD	Saddle Mountain	7,940	PS	1967-77
			SN	1965

(con.)

Table 11 (Con.)

Storage precipitation gages, recording precipitation gages, snow survey courses, and SNOTEL (snow telemetry) stations[8]

ID[9]	Station name	Elev.	Station[10] type	Period of record
SEC	Secesh Summit	6,520	SN	1942-50, 67-
SIL	Silver Creek Ridge	5,700	SC	1964-73
SQF	Squaw Flat	6,240	SN	1962-73, 80-
SQM	Squaw Meadow	5,900	SC	1936-
SRD	Sourdough Ridge	6,800	PSz	1977-83
STB	Stibnite Storage	6,500w	PS	1966-76
SWL	Schwartz Lake	8,540	SC	1962-
SYR	Sawyer Ridge	7,293	PSz	1975-
TWP	Twin Peaks	9,190w	SC	1963-
WCC	Wilson Cow Camp	7,450	PSz	1976-83
WBR	West Branch	5,560	SN	1981-
WFR	West Fork Rapid R.	2,700	PSz	1972-83
WLC	Williams Crk Summit	7,990	SC	1937-83

Table 11 (Con.)

Streamgauging stations

ID[13]	Station, location[14]	Elev.	Drainage name and area, mi^2		Period of record
BC	Big Creek, 19 E	3,950	Big Creek	470	1944-58
CH	Cape Horn, 2 NW	6,435	Middle Fork Salmon R.	138	1928-72
KR	Krassel, 1 N (of RS)	3,750	South Fork Salmon R.	330	1966-86
KX	Knox, 1.5 SW	5,090	South Fork Salmon R.	92	1928-60
MF	Middle Fork Lodge	4,380	Middle Fork Salmon R.	770	1973-81
MY	Meyers Cove, 15 NW	3,550	Middle Fork Salmon R.	2,020	1931-39
SH	Shoup, 7 SW	3,265	Panther Creek	529	1944-77
ST	Stibnite, 3 N	5,912	East Fork S. Fk Salmon	43	1928-41
WB	White Bird	1,413	Salmon River	13,550	1910-
YP	Yellow Pine	4,656	Johnson Creek	213	1928-

[1]Beginning and ending years with at least 3 months of data; blank denotes continuation through 1986.
[2]Moves of 100 ft or greater.
[3]GS denotes Guard Station; RS, Ranger Station; LO, lookout; SO, Forest Supervisor's office.
[4]National Forests. Bitterroot and Nez Perce are in Forest Service Northern Region; others, in Intermountain Region.
[5]For Intermountain Region stations, data for this report were available only from years 1932-38, 1953-55, 1958-60, and 1964-83 (see text).
[6]Symbol < denotes record may have begun somewhat earlier; data for documentation unavailable.
[7]Symbol + denotes record ended sometime between 1938 and 1953 or between 1960 and 1964.
[8]Snow data from USDA Soil Conservation Service. Precipitation data published by U.S. Weather Bureau and successor agencies, except as noted.
[9]Three-letter abbreviations used in figures 2, 4, and 12.
[10]SC denotes snow course; SN, snow course plus SNOTEL (generally beginning about 1980); PS, storage precipitation gauge; PR, year-round recording precipitation gauge.
[11]Letter z denotes data from annual hydrometeorological summaries by Nez Perce National Forest.
[12]Snow course also at nearby Deadwood Dam during 1936-74.
[13]Two-letter abbreviations used in figure 14.
[14]Distance, air miles, from place named.

Table 12—Illustration of adjustment of averages to standard 30-year normals; for monthly average daily maximum and minimum temperatures, °F, at Campbell's Ferry, ID, using "difference method"

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
(1) Observed averages at Campbell's Ferry, 1976-85													
No. years data		7	9	9	8	8	9	6	7	6	9	8	9
Avg. Max.		34.6	43.1	53.1	62.3	69.1	80.0	90.6	91.6	78.8	61.7	45.7	34.5
Min.		17.9	23.1	29.1	34.0	40.4	46.6	51.8	51.5	44.0	34.3	27.4	20.8
(2) Differences, for same years, (1) minus averages at indicated stations[1]													
Dixie	Max.	+5.0	+8.0	+13.5	+15.8	+14.7	+15.0	+15.7	+16.1	+13.7	+8.6	+7.5	+4.8
	Min.	+16.0	+15.4	+14.0	+13.3	+11.4	+12.4	+13.5	+15.5	+14.7	+11.5	+13.7	+15.5
Elk City	Max.	+1.6	+2.3	+5.9	+7.9	+8.2	+9.1	+9.7	+9.7	+7.2	+2.9	+1.3	+1.3
	Min.	+9.7	+9.1	+8.7	+8.3	+7.9	+8.6	+11.8	+13.1	+11.8	+8.4	+7.4	+10.9
Grangeville	Max.	−1.0	−0.2	+4.3	+5.6	+6.9	+8.6	+10.2	+10.5	+7.9	+2.8	+0.8	−3.1
	Min.	−2.2	−2.1	+0.2	+1.3	+1.9	+1.2	+1.8	+1.7	+2.3	0.0	−0.6	−1.5
Grangeville	Max.	−1.3	−2.0	+0.4	+0.7	+2.2	+3.7	+6.8	+6.6	+3.7	+0.1	+0.1	−2.0
11 SE	Min.	−3.5	−3.7	−2.0	−0.8	0.0	0.0	+0.6	+2.4	+1.7	−0.7	−2.3	−3.1
Riggins	Max.	−8.6	−5.9	−4.3	−4.2	−3.9	−1.6	−0.1	−0.6	−2.2	−5.2	−4.7	−6.6
	Min.	−8.0	−8.9	−7.0	−6.7	−6.0	−6.5	−7.4	−7.3	−5.9	−6.7	−7.0	−8.3
Shoup	Max.	+6.2	+5.1	+3.1	+1.1	+0.1	+0.9	+2.7	+4.2	+2.6	+1.6	+4.0	+4.4
	Min.	+4.4	+4.0	+1.8	+1.5	+1.5	+1.6	+1.4	+1.1	+2.7	+1.5	+2.2	+4.1
(3) Normals, based on 1951-80, at above six stations; see table 20 (appendix)[2]													
(4) Calculated normals at Campbell's Ferry, adding (2) to (3), based on indicated stations													
Maximum													
Dixie		34.2	42.6	50.8	60.9	70.2	80.0	91.8	91.4	79.6	62.1	45.5	35.7
Elk City		35.2	43.0	49.8	60.1	69.9	79.2	90.8	90.0	78.0	61.8	44.5	36.4
Grangeville		35.5	42.1	50.8	60.5	70.4	80.0	92.5	92.0	79.8	62.1	45.6	35.7
Grangeville 11 SE		35.7	43.3	51.2	60.5	69.9	79.2	92.8	92.2	79.7	62.4	46.2	36.2
Riggins		32.8	43.5	51.6	61.0	69.8	80.5	92.9	91.3	79.8	62.6	46.5	36.4
Shoup		36.5	44.2	51.7	61.7	70.6	79.3	91.3	90.0	78.1	62.2	46.2	36.9
Minimum													
Dixie		19.4	22.4	24.1	33.6	39.4	46.7	50.7	50.5	43.8	33.9	27.1	22.0
Elk City		18.9	23.4	25.5	33.9	40.6	47.4	52.3	51.4	44.9	35.1	27.5	23.5
Grangeville		17.9	22.4	26.3	33.2	40.3	46.1	51.8	50.4	44.0	34.0	26.2	21.3
Grangeville 11 SE		19.0	23.5	27.3	34.0	40.7	46.8	51.6	51.7	44.8	35.5	27.4	22.1
Riggins		19.5	22.4	26.7	31.9	39.9	46.1	51.7	50.8	44.9	35.5	27.0	21.7
Shoup		19.6	24.4	27.0	34.3	40.5	47.0	52.1	50.3	44.5	35.1	28.2	23.2
(5) Estimated normals at Campbell's Ferry, based on weighted six-station average from (4)[3]													
	Max.	34.9	43.3	51.2	60.9	70.2	79.8	92.0	91.0	79.1	62.3	45.9	36.3
	Min.	19.2	23.2	26.3	33.4	40.2	46.7	51.8	50.8	44.6	35.0	27.4	22.4

[1]In cases of missing monthly data at these stations, differences are based on the corresponding, reduced numbers of years at Campbell's Ferry.
[2]Normals at most of these stations are also adjusted averages (obtained previously).
[3]Uses formula:

$$\left\{\frac{(D+E)}{2} + \frac{(G+GSE)}{2} + R + S\right\}/4,$$ where letters denote values based on the six respective stations.

Table 13—Illustration of adjustment of averages to standard 30-year normals; for monthly average precipitation, inches, at Campbell's Ferry, ID, using "ratio method"

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
(1) Observed averages at Campbell's Ferry, 1976-85 except longer period, since 1960, for fire season													
No. years data	7	9	9	8	15	20	25	26	22	16	10	10	
Avg. precip.	1.68	1.68	1.91	2.06	2.82	2.73	1.08	1.24	1.76	1.86	1.89	2.51	23.22
(2) Weighted averages, applying a running 1-4-1, three-point weighting to monthly values in (1)[1]													
	1.82	1.72	1.90	2.16	2.68	2.47	1.38	1.30	1.69	1.85	1.99	2.27	
(3) Ratios, for same years, (2) divided by similarly weighted averages at indicated stations[2,3]													
Dixie	.659	.667	.757	.981	1.051	.969	.908	.890	.962	.922	.777	.711	.840
Elk City	.603	.694	.771	.809	.836	.843	.784	.818	.876	.889	.841	.735	.790
Grangeville	1.301	1.075	.757	.783	.851	.901	.945	.977	.966	1.078	1.131	1.377	.975
Riggins	1.895	1.395	1.107	1.219	1.394	1.390	1.340	1.358	1.532	1.480	1.620	1.929	1.447
Shoup	1.111	1.485	1.940	1.832	1.540	1.394	1.274	1.354	1.555	1.818	1.461	1.241	1.481
Warren	.861	.855	.773	1.019	1.103	1.021	.952	.922	.934	.864	.777	.868	.910
(4) Normals, based on 1951-80, for above six stations (from table 14, appendix)													
Dixie	4.24	2.77	3.07	2.41	2.71	2.80	1.07	1.43	1.61	2.24	2.99	3.85	31.19
Elk City	3.47	2.42	2.50	2.50	3.08	2.87	1.24	1.53	1.75	2.15	2.68	3.27	29.46
Grangeville	1.70	1.24	2.07	2.73	3.43	2.89	.96	1.32	1.69	2.00	1.77	1.62	23.42
Riggins	1.50	1.19	1.65	1.75	2.00	1.85	.73	.95	1.09	1.37	1.35	1.52	16.95
Shoup	1.48	1.03	.92	1.15	1.65	2.00	.82	.90	1.00	.91	1.25	1.65	14.76
Warren	3.60	2.40	2.75	2.33	2.70	2.73	.95	1.32	1.60	2.20	2.60	3.20	28.38
(5) Calculated normals at Campbell's Ferry, multiplying (3) by (4), based on indicated stations													
Dixie	2.79	1.85	2.32	2.36	2.85	2.71	.97	1.27	1.55	2.07	2.32	2.74	26.20
Elk City	2.09	1.68	1.93	2.02	2.57	2.42	.97	1.25	1.56	1.91	2.26	2.40	23.26
Grangeville	2.21	1.33	1.57	2.14	2.92	2.60	.91	1.29	1.63	2.16	2.00	2.23	22.83
Riggins	2.84	1.66	1.83	2.13	2.79	2.57	.98	1.29	1.67	2.03	2.19	2.93	24.52
Shoup	1.64	1.53	1.78	2.11	2.54	2.79	1.04	1.22	1.56	1.65	1.83	2.05	21.86
Warren	3.10	2.05	2.13	2.37	2.98	2.79	.90	1.22	1.49	1.90	2.02	2.78	25.83
(6) Estimated normals at Campbell's Ferry, based on unweighted six-station average from (5)[4]													
	2.45	1.68	1.93	2.19	2.78	2.65	.96	1.26	1.58	1.95	2.10	2.52	24.05

[1]For calculation purposes only, to smooth sample irregularity in trend of monthly ratios (step 3).
[2]In cases of missing monthly data at these stations, ratios are based on the corresponding, reduced numbers of years at Campbell's Ferry.
[3]Annual ratio is based on sums of unweighted monthly averages.
[4]Listed annual normal is sum of monthly normals; separately calculated annual normal is only 0.03 inch different.

Table 14—Monthly average precipitation (P) and snowfall (S), inches, in or adjacent to RNR; based on or adjusted to 30-year normal period 1951-80, except as noted. P includes measured snowfall water content. T denotes trace, an amount too small to measure; blank monthly columns, months without observed snowfall or (if all blank) insufficient basis for calculating monthly averages. Estimates or slight adjustments were made for occasional missing data occurring at long-term stations. Adj. denotes adjustment of shorter period station averages. (f) denotes former station, not continuing through year 1985; (o), old station, closed before 1930

Station, elev. (ft)			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
			Inches												
Big Creek 1 S	(f)	P	4.13	2.85	2.83	2.30	2.43	2.53	1.10	1.35	1.70	2.20	2.70	3.70	29.82
5,686 Adj.		S	38.5	27.0	25.0	11.8	5.0	0.5	T	T	0.4	5.0	18.3	34.8	166.3
Blackbird Mine	(f)	P	2.40	1.85	2.10	2.03	2.35	2.60	1.00	1.20	1.15	1.45	2.12	2.50	22.75
6,825 Adj.		S	26.5	22.0	23.0	13.5	7.0	1.0	0.1	0.2	1.5	6.0	20.0	24.5	145.3
Campbell's Ferry		P	2.45	1.68	1.93	2.19	2.78	2.65	.96	1.26	1.58	1.95	2.10	2.52	24.05
2,310 Adj.[1]		S	25.0	11.7	8.0	2.2	T					0.3	5.7	20.0	72.9
Cascade 1 NW		P	3.06	1.96	1.88	1.51	1.62	1.83	.39	.80	1.08	1.74	2.39	3.17	21.43
4,896		S	29.7	17.4	15.1	4.8	0.9	T			T	1.5	10.9	23.5	103.8
Challis		P	.55	.36	.40	.58	1.11	1.17	.54	.59	.67	.38	.42	.61	7.38
5,175		S	5.5	3.0	2.5	1.0	0.1				0.1	0.1	2.5	4.7	19.5
Cobalt		P	1.65	1.10	1.15	1.52	2.03	2.25	.95	1.13	1.15	1.05	1.30	1.75	17.03
5,010 Adj.		S	20.0	12.0	11.5	7.5	1.3	0.1			0.5	1.6	8.0	16.0	78.5
Darby, MT		P	1.72	1.07	.96	1.11	1.93	1.80	.78	.98	1.22	1.12	1.49	1.63	15.81
3,880															
Deadwood Dam	(f)	P	5.49	3.57	3.19	2.01	1.92	2.00	.57	.93	1.22	2.20	3.68	5.40	32.18
5,375 Adj.		S	49.7	35.0	24.8	12.0	3.3	0.1			0.1	4.5	23.0	45.3	197.8
Dixie		P	4.24	2.77	3.07	2.41	2.71	2.80	1.07	1.43	1.61	2.24	2.99	3.85	31.19
5,620 Adj.		S	56.0	35.0	38.0	18.2	7.5	0.5		T	1.0	8.2	25.0	48.0	237.4
Elk City		P	3.47	2.42	2.50	2.50	3.08	2.87	1.24	1.53	1.75	2.15	2.68	3.27	29.46
4,058 Adj.		S	36.0	23.2	23.3	12.2	2.5	T			0.1	2.7	13.5	28.0	141.5
Gibbonsville		P	2.15	1.35	1.00	1.20	1.90	2.02	.92	1.00	1.05	.98	1.50	2.13	17.20
4,480 Adj.		S	26.0	14.0	7.0	3.0	0.8	T			T	1.0	9.5	24.0	85.3
Grangeville		P	1.70	1.24	2.07	2.73	3.43	2.89	.96	1.32	1.69	2.00	1.77	1.62	23.42
3,355		S[2]	11.9	7.0	11.3	4.1	0.5					1.7	6.6	13.4	56.5
Grangeville 11 SE		P	1.96	1.57	2.53	2.98	3.63	3.05	1.03	1.35	1.80	2.15	2.05	2.03	26.13
2,250 Adj.		S	12.2	5.8	5.2	1.1	0.2					0.5	5.0	10.0	40.0
Loon Creek	(o)	P	1.95	1.35	1.35	1.20	1.50	1.65	.65	1.00	1.25	1.20	1.65	1.90	16.60
5,810 Adj.		S[3]													80.6
McCall		P	4.29	2.84	2.68	2.08	2.14	2.11	.57	1.10	1.50	2.02	2.89	3.85	28.07
5,025		S	48.0	29.2	26.5	8.5	1.1				0.1	2.5	17.8	37.6	171.3
Middle Fork Lodge		P	2.05	1.33	1.25	1.22	1.50	1.72	.70	1.05	1.12	1.33	1.63	1.90	16.80
4,480 Adj.		S	16.5	9.3	6.3	2.7	0.2	T				0.7	7.0	11.0	53.7
New Meadows R.S.		P	4.00	2.44	2.31	1.88	1.88	1.88	.54	.82	1.32	1.95	2.76	3.82	25.60
3,870		S	29.7	15.5	10.3	2.3	0.3	T			0.1	1.2	9.0	27.0	95.4
Riggins R.S.		P	1.50	1.19	1.65	1.75	2.00	1.85	.73	.95	1.09	1.37	1.35	1.52	16.95
1,800		S[4]													10.0
Roosevelt	(o)	P													26.50
7,500 Adj.[1]		S[3]													190.0
Salmon-Salmon 1 N		P	.75	.55	.54	.82	1.34	1.65	.73	.78	.66	.58	.71	.81	9.92
3,940		S	9.0	5.0	3.0	2.0	0.1				T	0.1	3.0	7.5	29.7
Shoup		P	1.48	1.03	.92	1.15	1.65	2.00	.82	.90	1.00	.91	1.25	1.65	14.76
3,400 Adj.		S	14.3	6.3	1.7	0.3	T					0.1	3.7	13.7	40.1
Slate Creek R.S.	(f)	P	1.32	.98	1.47	1.78	2.43	2.38	.75	1.03	1.15	1.27	1.22	1.32	17.10
1,568 Adj.		S	4.3	1.7	1.0	T						T	1.0	2.0	10.0
Stibnite	(f)	P	4.65	3.15	3.15	2.35	2.25	2.35	.80	1.30	1.75	2.25	3.10	4.20	31.30
6,550 Adj.[1]		S	47.5	34.0	32.0	20.0	11.0	0.7	T	0.1	1.0	7.5	27.0	40.0	220.8
Taylor Ranch		P													15.00
3,835 Adj.[1]		S													47.0
Warren		P	3.60	2.40	2.75	2.33	2.70	2.73	.95	1.32	1.60	2.20	2.60	3.20	28.38
5,899 Adj.		S	44.0	27.0	32.0	17.0	7.0	0.5		T	0.7	8.0	20.5	37.0	193.7
Yellow Pine 7 S		P	3.93	2.60	2.37	1.93	2.10	2.15	.65	1.15	1.65	2.23	2.97	3.77	27.50
5,070 Adj.		S	30.5	21.0	16.5	8.5	1.8	T			0.3	3.5	13.7	28.5	124.3

(con.)

Table 14 (Con.)

Station, elev. (ft)		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
		Inches												
SNOTEL Stations:														
Big Creek Summit 6,580 Adj.[5]	P	8.00	5.55	5.50	4.05	3.10	2.30	.60	1.20	1.95	3.45	5.40	7.50	48.60
Secesh Summit 6,520 Adj.[5]	P	8.50	6.05	5.75	4.45	3.60	3.10	.85	1.20	1.90	3.50	5.90	8.00	52.80

[1]Adjustment calculations based on less than 10 years of data, except for many additional years at Campbell's Ferry during May-October from fire-weather observations.
[2]Snowfall data missing for about 5 years but no adjustment made.
[3]Snowfall average as observed; adjacent stations insufficient for adjustment calculations or estimates.
[4]Annual average estimated; snowfall record very incomplete but amounts are normally small. Available 1951-80 data gave annual average of 7 inches; rather complete 1931-52 data gave 10.7 inches.
[5]Adjustment calculations based on 5 years of data, 1982-86.

Table 15—Monthly and annual precipitation, inches, by individual years; at available, moderately wet long-term stations adjacent to RNR. Data from standard gauge (nonrecording gauge) measurements. T denotes trace, amount too small to measure. E denotes amount estimated in whole or part (for missing data), different from originally published value or estimate; F, from fire-weather data. P denotes estimate as published

McCall, ID

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Precipitation												
	Inches												
1917	2.36	3.10	2.32	2.92	2.02	1.24	T	0.30P	3.15E	0.61	3.71	5.94	27.67
1918	4.34	3.42	2.30	1.54	.78	.67	.90P	1.28	.75	3.61	1.08	1.43	22.10
1919	3.02	4.59	2.24	2.40	1.05	T	.05	.09	.62	2.10	3.42	3.85	23.43
1920	1.52	.51	4.46	1.99	.83	1.33	.22	.95E	1.77	4.16	3.32	4.36	25.42
1921	5.00	2.18	1.94	2.22	2.92	.61	T	1.46	1.27	1.31	3.98	2.39	25.28
1922	2.56	3.80	4.55	2.45	1.57	.36	.99	1.00	.18	.44	.66	6.39	24.95
1923	5.63	2.50	1.90	2.80	2.09	4.94	1.42	1.27	.47	2.31	1.82	2.77	29.92
1924	2.62	3.04	.82	.77	.02	1.21	.10	1.14	.74	3.14	3.49	2.98	20.07
1925	4.38	5.17	2.41	2.71	2.08	2.22	.20	1.35E	1.35	1.45E	1.87	3.18	28.37
1926	1.21	5.90	.90	.48	2.49	1.11	.10	3.34	1.49	1.10	7.51	3.17	28.80
1927	2.67	5.65	1.53	1.76	2.08	.97	.17	.62	3.40	1.91	6.52	2.52	29.80
1928	3.18	.52	3.70	2.47	.15	.43	.50	.08	.42	1.58	.88	1.71	15.62
1929	2.18	1.45	1.36	3.62	1.08	1.35	.00	.00	.00	.80P	.15P	6.29	18.28
1930	1.97	3.22	1.20	3.29	2.29	1.10	.00	.44	.71	2.59	1.72	.58	19.11
1931	2.80	1.59	3.86	.47	.55	.53	T	.05	1.31	2.60	2.48	5.19	21.43
1932	2.38	1.59	5.40	2.42	3.25	.73	1.19	.33	.05	2.37	3.10	3.26	26.07
1933	4.53	1.97	.72	.70	2.31	1.69	.04	.15	.93	2.19	.99	6.21	22.43
1934	2.80	.73	2.54	.74	.66	1.99	.02	.63	.55	2.35	2.33	2.48	17.82
1935	2.64	.83	1.83	2.40	.75	.95	.26	.11	.16	1.69	.78	1.47	13.87
1936	6.98	4.18	2.09	1.66	2.04	1.92	.52	.62	.42	.27	.09	2.06	22.85
1937	3.77	4.76	.96	3.01	1.08	2.19	.52	.12	.44	1.33	4.09	4.77	27.04
1938	2.19	5.79	4.57	1.77	2.70	1.78	1.75	.43	.92	2.17	2.71	1.91	28.69
1939	2.93	3.65	3.09	.45	1.02	1.50	1.11	.18	1.71	2.52	.06	4.42	22.64
1940	4.43	6.05	5.24	2.42	.39	.50	.37	.02	4.63	3.55	3.31	2.71	33.62
1941	3.27	2.49	1.10	1.66	4.73	4.13	1.13	2.06	.61	1.87	3.64	5.52	32.21
1942	2.22	3.33	.97	2.81	5.34	2.10	.80	.43	.15	1.74	5.97	5.85	31.71
1943	5.76	2.25	1.77	2.09	1.43	3.11	1.10	.58	.26	3.85	1.36	1.63	25.19
1944	.94	2.62	1.69	2.81	1.06	4.72	.38	.46	1.29	.81	3.62	1.70	22.10
1945	2.87	3.43	3.20	1.24	5.63	3.09	.45	.15	2.29	1.07	5.14	4.03	32.59
1946	2.90	3.96	1.97	1.25	2.00	1.02	.86	.30	2.88	3.36	7.49	2.83	30.82
1947	2.12	1.62	2.57	.61	1.93	3.99	.00	.14	1.42	4.36	2.38	2.44	23.58
1948	2.88	2.97	3.73	3.64	4.28	2.90	1.10	.71	.85	1.99	4.25	4.33	33.63
1949	1.69	5.09	1.36	.72	2.60	.35	.22	.30	2.12	1.32	3.16	3.15	22.08
1950	5.55	2.96	4.59	1.60	.62	2.19	.04	.96	.85	4.96	2.24	4.19	30.75
1951	3.61	3.62	5.56	.68	1.19	2.47	.59	1.18	.48	6.47	3.35	6.93	36.13
1952	4.78	2.82	2.61	.49P	2.65	2.14	.33	.12	.47	.21	.93	4.62	22.17
1953	7.63	2.56	2.66	3.11	3.14	3.63	.00	2.01	.00	.48	2.12	2.65	29.99
1954	6.96	4.19	2.42	2.88	1.67	2.71	.84	1.07	.60	.61	1.17	1.89	27.01
1955	1.89	1.92	2.17	4.17	1.81	1.26	1.18	.02	1.52	1.90	4.07	7.72	29.63
1956	4.29	3.49	1.46	.52	3.65	1.77	.56	1.03	.27	5.53	.56	2.63	25.76
1957	2.96	3.72	3.77	2.49	4.82	1.60	.20	.42	.38	2.20	1.35	4.26	28.17
1958	3.33	3.94	2.16	3.83	.44	3.73	.49	.63	1.20	.57	3.56	2.89	26.77
1959	5.26	3.59	2.27	1.35	3.03	.99	.12	1.20	6.43	2.65	1.05	1.35	29.29
1960	2.26	2.88	4.17	2.20	3.67	.29	.47	1.79	.58	1.51	6.07	.93	26.82

(con.)

Table 15 (Con.)

McCall, ID (Con.)

Year	Precipitation												
	Jan.	**Feb.**	**Mar.**	**Apr.**	**May**	**June**	**July**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**	**Annual**
	Inches												
1961	2.41	2.84	2.75	1.60	2.41	.74	.22	.61	1.13	2.80	2.95	3.27	23.73
1962	2.29	3.33	2.61	1.62	4.03	.72	.49	1.11	1.10	6.45	3.66	2.11	29.52
1963	1.58	2.28	3.19	3.18	1.91	3.36	.22	.20	1.57	1.34	3.92	2.09	24.84
1964	5.28	.62	4.03	2.03	1.02	5.57	.66	1.44E	1.16	.85	3.37	8.75	34.78
1965	8.45	1.74	.32	4.01	.77	1.81	.22	2.83F	1.76	.71	2.35	1.25	26.22
1966	4.76	1.72	3.41	1.29	.52	1.15	.06	.19F	1.10	1.12	4.56	4.48	24.36
1967	6.45	.92	3.36	3.01	2.07	1.91	.22	T	2.46	3.63	1.48	3.88	29.39
1968	2.78	3.24	1.62	1.03	2.20	.84	.27	3.27	1.31	2.33	4.37	3.96	27.22
1969	6.21	2.33	.72	1.68	1.67	3.07	.00	T	2.80	1.55	.81	3.69	24.53
1970	7.67	1.73	1.78	1.52	1.76	4.26	.04	T	4.00	2.04	4.48	5.57	34.85
1971	5.38	1.60	3.10	0.68	1.93	4.73	0.06	0.13F	0.78	1.07	2.84	5.20	27.50
1972	3.48	3.91	2.58	2.60	1.88	2.11	.28	.66	1.27	1.15	2.16	3.77	25.85
1973	3.99	1.10	1.74	.87	1.85	1.24	.26	.81F	2.37	1.56	9.25	5.04	30.08
1974	6.24	3.20	5.07	2.15	.76	1.19	1.05	.76	.11	.36	2.46	4.49	27.84
1975	3.48	5.62	3.69	2.32	1.44	1.83	1.53	3.30	.06	5.51	3.81	2.67	35.26
1976	4.48	2.87	2.11	2.07	1.63	1.50	2.43	3.25	1.77	.54	.36	.81	23.82
1977	.90	.90	2.70	.28	2.51	.84	2.01	1.92	3.11	1.03	3.80	6.87	26.87
1978	4.13	3.06	1.68	4.19	2.22	2.01	1.32	1.68	2.06	.05	1.47	2.62	26.49
1979	1.89	5.50	1.65	2.05	1.29	.59	.11	1.34	.04	3.31	1.87	2.80	22.44
1980	3.74	3.81	2.97	2.41	4.24	3.36	.83	.41	3.10	1.10	2.44	6.44	34.85
1981	2.07	3.21	1.75	1.89	3.34	2.61	1.14	.17	1.31	3.13	4.99	4.46	30.07
1982	4.43	4.97	3.15	2.91	1.58	2.83	1.40	.14	2.37	4.45	2.95	5.52	36.70
1983	2.55	4.97	4.38	1.78	1.17	1.53	2.07	1.70	.86	1.69	5.58	5.49	33.77
1984	1.77	3.32	3.17	1.60	2.38	3.71	2.22	1.82	1.94	1.75	3.42	2.07	29.17
1985	.41	2.01	1.75	.65	1.84	.76	.77	.64	5.24	1.86	2.89	1.39	20.21
1986	2.90	5.65	2.40	2.09	2.02	1.78	1.02	.65	4.22	.77	2.40	.39	26.29
1987	2.91	2.14	2.99	.62	1.43	1.47	1.20	.54	.01	.00	2.10	2.82	18.23
10-year averages													
1921-30	3.14	3.34	2.03	2.26	1.68	1.43	.35	1.07	1.00	1.66	2.86	3.20	24.02
1931-40	3.55	3.11	3.03	1.60	1.48	1.38	.58	.26	1.11	2.10	1.99	3.45	23.65
1941-50	3.02	3.07	2.30	1.84	2.96	2.76	.61	.61	1.27	2.53	3.93	3.57	28.47
1951-60	4.30	3.27	2.93	2.17	2.61	2.06	.48	.95	1.19	2.21	2.42	3.59	28.18
1961-70	4.79	2.08	2.38	2.10	1.84	2.34	.24	.97	1.84	2.28	3.20	3.91	27.94
1971-80	3.77	3.16	2.73	1.96	1.98	1.94	.99	1.43	1.47	1.57	3.05	4.07	28.10
30-year averages													
1921-50	3.24	3.18	2.45	1.90	2.04	1.86	.51	.65	1.13	2.10	2.93	3.40	25.38
1931-60	3.62	3.15	2.75	1.87	2.35	2.07	.56	.61	1.19	2.28	2.78	3.54	26.76
1941-70	4.04	2.81	2.54	2.04	2.47	2.39	.44	.84	1.43	2.34	3.18	3.69	28.20
1951-80	4.29	2.84	2.68	2.08	2.14	2.11	.57	1.11	1.50	2.02	2.89	3.86	28.07

(con.)

Table 15 (Con.)

Deadwood Dam, ID[1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Precipitation												
	Inches												
1931	M	M	M	0.56	T	0.01	0.28	T	1.37	1.18	3.04	13.67	M
1932	4.16	1.84	9.10	.88	2.04	2.29	2.04	.67	T	1.07	3.22	6.50	33.81
1933	10.18	6.30	1.45	.81	4.31	1.80	.05	.60	.81	3.05	.81	9.85	40.02
1934	2.92	.72	3.40	1.25	.29	1.99	2.68	1.04	.14	3.15	3.64	4.39	25.61
1935	4.12	.68	2.88	4.47	1.09	.49	.13	T	.14	1.34	1.10	2.98	19.42
1936	8.66	7.89	1.90	2.04	1.50	2.79	1.19	1.76	.67	.11	.19	2.99	31.69
1937	5.04	5.74	3.06	3.58	.82	3.96	.14	.00	.48	1.30	6.05	7.20	37.37
1938	4.98	6.26	9.35	2.93	1.57	1.80	2.36	.58	.95	3.62	3.48	2.82	40.70
1939	4.25	3.90	3.62	1.07	.51	1.60	.77	.30	1.88	2.27	.32	7.15	27.64
1940	5.36	10.99	5.97	2.31	.42	.51	.40	.05	4.95	3.59	4.34	5.82	44.71
1941	4.06	4.04	.77	1.39	5.32	2.04	1.52	3.62	.93	1.61	5.07	10.80	41.17
1942	3.66	3.01	.94	1.89	2.92	1.15	.20	.16	.21	1.01	8.48	9.01	32.64
1943	7.99	2.79	4.39	2.84	2.20	2.02	.60	.65	.13	4.04	2.45	1.33	31.43
1944	1.62	3.39	2.27	2.62	1.76	4.02	.39	T	.68	1.98	3.87	3.30	25.90
1945	2.40	4.83	3.61	1.08	5.25	2.75	.09	.46	.99	1.79	6.22	6.38	35.85
1946	3.83	3.61	3.49	1.65	2.57	.64	.74	.48	2.30	2.70	9.61	3.01	34.63
1947	2.49	2.51	2.63	.63	1.55	3.54	.00	.27	.92	4.86	1.94	1.40	22.74
1948	4.87	4.36	2.87	4.06	2.20	2.08	.08	.29	1.09	1.03	4.75	7.19	34.87
1949	1.11	7.08	.81	.42	3.19	.94	.14	.06	.91	1.52	3.00	3.19	22.37
1950	9.23	3.89	6.38	1.29	.49	1.25	.10	.74	1.47	5.32	3.02	4.11	37.29
1951	5.11	4.25	4.18	1.87	1.83	1.92	.69	1.93	.49	6.22	4.21	8.52	41.22
1952	4.90	2.81	1.84	.78	2.03	2.17	.30	.08	.11	.08	1.33	6.31	22.74
1953	8.55	3.78	2.80	1.74	3.13	2.09	.01	.47	.07	.24	4.34	2.93	30.15
1954	8.13	4.01	3.57	2.97	1.53	3.30	.41	.59	.20	.32	1.80	2.79	29.62
1955	1.57	2.31	3.51	4.01	1.46	.89	.99	.02	1.29	2.41	6.30	11.82	36.58
1956	4.89	4.22	1.60	1.03	2.83	1.56	.37	.18	.45	6.47	1.25	2.96	27.81
1957	3.26	7.10	4.33	1.80	3.46	.55	.05	.48	.15	1.87	1.50	7.37	31.92
1958	4.30	5.01	3.07	4.05	1.90	3.40	1.11	.38	.55	.65	5.95	4.02	34.39
1959	7.04	3.82	2.50	1.26	2.79	.96	.06	.89	4.95	2.32	1.47	1.95	30.01
1960	2.95	4.52	4.61	1.30	2.41	.36	.27	1.27	.78	1.00	6.50	1.23	27.20
1961	2.12	4.30	3.53	1.45	2.03	.52	.24	.98	1.97	3.93	4.85	4.04	29.96
1962	1.98	4.59	3.45	1.93	3.09	1.45	.70	.35	1.44	6.56	5.16	2.98	33.68
1963	2.04	4.22	3.41	3.73	2.84	4.22	.07	.94	1.95	2.10	5.08	2.20	32.80
1964	6.01	.67	4.06	1.73	.67	4.57	1.01	1.12	.57	.84	5.37	16.61	43.23
1965	7.30	2.02	1.01	5.75	1.30	1.44	.65	2.00	.23	.73	3.19	2.67	28.29
1966	6.29	1.33	3.68	1.02	.61	.78	.11	.30	.53	.94	5.03	4.56	25.18
1967	7.85	.92	3.10	2.48	1.32	2.61	.45	T	1.68	3.68	.99	3.47	28.55
1968	3.27	5.52	1.56	.95	1.87	1.46	.15	3.59	.74	2.53	4.56	6.38	32.58
1969	12.21	3.50	1.35	1.11	1.13	2.70	.20	T	1.20	1.21	.87	5.81	31.29
1970	11.97	1.76	2.96	1.45	2.45	4.28	.91	.21	2.33	3.72	8.62	9.16	49.82
1971	7.47	2.55	6.50	.79	1.14	4.13	.55	.21	.54	.99	3.53	5.89	34.29
1972	6.16	4.51	2.61	2.76	.77	2.98	.05	.68	1.22	1.99	1.78	6.80	32.31
1973	5.56	1.87	1.47	1.27	1.21	1.14	.64	.48	2.00	2.09	8.69P	6.50	32.92
1974	9.51	2.70	8.65	1.42	.33	1.09	1.08	1.15	T	1.26	M	M	M
10-year averages													
1931-40	[2]5.52	[2]4.43	[2]4.53	1.99	1.79	1.72	1.00	.50	1.14	2.07	2.62	6.34	33.65
1941-50	4.13	3.95	2.82	1.79	2.75	2.04	.39	.67	.96	2.59	4.84	4.97	31.89
1951-60	5.07	4.18	3.20	2.08	2.34	1.72	.43	.63	30	2.16	3.47	4.99	31.17
1961-70	6.10	2.88	2.81	2.16	1.73	2.40	.45	.95	1.26	2.62	4.37	5.79	33.54

(con.)

Table 15 (Con.)

Dixie, ID[3]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
							Inches						
1952	M	M	M	M	M	M	0.94	0.65	0.25	0.27	0.54	2.58	M
1953	8.02	3.49	2.96	2.71	3.61	2.17	.03	.95	.15	.58	3.00	4.53	32.20
1954	5.24	2.33	3.22	3.76	1.45	4.37	1.21	2.68	.53	1.22	1.10	1.54	28.65
1955	1.60	3.15	3.51	2.80	2.41	2.31	1.68	T	1.51	3.65	6.99	4.33	33.94
1956	3.10	2.82	3.71	.20	2.95	2.57	1.14	3.69	.07	2.92	2.00	3.68	28.85
1957	2.58	2.58	3.25	2.36	6.45	2.26	.56	1.29	T	1.17	2.26	5.22	29.98
1958	2.79	1.78	1.60	3.98	2.04	5.12	1.92	1.61	1.70	1.94	4.04	3.69	32.21
1959	4.29	2.52	2.98	1.14	3.84	1.81	.64	.91	4.94	4.10	2.91	.86	30.94
1960	1.41	2.65	3.33	3.38	4.57	.80	.62	1.98	.84	2.65	4.98	1.86	29.07
1961	1.53	4.00	3.38	3.88	4.09	1.32	.38	.85	2.33	3.65	4.20	4.27	33.88
1962	3.84	1.93	3.05	1.80	4.10	2.10	.10	.95	1.53	4.25	3.85	1.70	29.20
1963	2.48	3.01	3.11	3.29	2.34	6.44	.72	.37	1.24	1.89	3.27	2.70	30.86
1964	6.89	1.86	6.01	2.33	2.32	4.55	2.10	3.30	1.09	1.32	2.70	9.76	44.23
1965	8.09	3.52	.89	3.54	1.84	1.82	1.35	3.26	1.94	1.01	1.93	1.21	30.40
1966	3.26	2.72	2.40	1.65	1.34	3.75	.03	.48	1.11	1.87	2.22	3.48	24.31
1967	6.18	1.97	4.85	3.69	1.98	3.54	.68	.61	1.30	5.59	3.02	4.49	37.90
1968	2.88	3.91	1.86	2.36	2.72	1.92	1.09	2.86	2.72	2.78	3.96	4.20	33.26
1969	6.67	1.47	1.26	1.44	1.94	5.00	.13	.03	2.29	2.81	1.17	2.81	27.02
1970	6.39	1.85	3.56	2.76	1.64	3.49	1.24	.07	4.57	2.00	3.35	3.45	34.37
1971	8.17	3.19	3.10	2.11	2.50	3.18	.32	.47	1.60	1.01	3.40	5.60	34.65
1972	7.72	5.45	3.99	3.11	1.41	1.84	1.01	.27	1.81	.87	2.26	4.49	34.23
1973	1.77	.71	2.16	1.82	1.89	2.15	.61	.48	2.49	1.50	7.28	4.98	27.84
1974	6.00	4.16	6.67	2.08	1.28	2.06	1.51	1.64	.26	.56	1.79	4.63	32.64
1975	7.41	3.66	2.26	4.18	2.69	2.44	.84	2.94	.28	5.96	3.74	6.44	42.84
1976	4.30	3.40	2.65	2.28	2.24	2.53	2.23	1.69	2.02	1.13	.68	1.37	26.52
1977	1.38	1.18	5.08	.84	3.30	1.39	2.67	2.09P	3.75	2.61	4.11	5.72	34.12
1978	2.71	2.80	1.37	3.26	3.09	1.77	1.30	2.69	1.67	.06	1.51	5.25	27.48
1979	2.06	4.52	1.38	2.45	1.97	1.79	1.60	2.12	.15	1.99	1.63	1.65	23.31
1980	2.87	1.75	2.61	1.35	3.55	3.55	2.23	.64	3.65	1.00E	2.85E	4.04	30.09
1981	.67	2.96	2.00E	1.69	2.47	5.33	1.52	.63E	1.54	1.24	2.38	4.89	27.32
1982	5.19	3.52	1.79	2.42E	1.90E	2.11	2.18	1.30E	1.70	3.00E	1.58	3.35	30.04
1983	3.35	2.07	3.32	1.51	2.36	3.90	2.72	2.64	1.59	2.10	4.11	3.35	33.02
1984	3.31	2.29	4.25	1.74	4.93	3.04	1.26	1.21	2.35E	1.59	3.70	4.74	34.41
1985	.94	4.20	2.05E	2.03	2.17	.51	1.17E	2.18E	3.85E	.95	2.59	.68	23.32
1986[4]	1.89	3.37	2.40	1.50	2.03	1.34	1.82	.80	1.99	M	3.58	.28	
10-year averages													
1951-60 (adjusted)	3.45	2.62	3.06	2.20	3.31	2.75	.99	1.51	1.03	2.33	3.07	3.34	29.66
1961-70	4.82	2.62	3.04	2.67	2.43	3.39	.78	1.28	2.01	2.72	2.97	3.81	32.54
1971-80	4.44	3.08	3.13	2.35	2.39	2.27	1.43	1.50	1.77	1.67	2.93	4.42	31.37
30-year average													
1951-80	4.24	2.77	3.07	2.41	2.71	2.80	1.07	1.43	1.61	2.24	2.99	3.85	31.19

[1]Station known as Deadwood, at nearby site, prior to May 1940; precipitation amounts apparently not compatible (relatively heavy at former location). Station closed 1974.

[2]Average for 9 years.

[3]Several changes in observer during 1980-85, affecting completeness and homogeneity of data.

[4]Some of observed amounts appear much too low in comparison with data from recording gauge at same location; for example, 3.20 inches in April, 2.90 inches in May, 4.90 inches in November 1986.

Table 16—Precipitation statistics for climatic stations in RNR vicinity; amounts in inches. Based on indicated years of record, 1951-80 where available. Number 0.00 denotes either zero or trace. Year (YR), first two digits omitted, is the most recent in cases of more than one occurrence

P R E C I P I T A T I O N BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 100835 BIG CREEK 1 S YRS 1949-1967

PERIOD BEGINS	NO. YRS	10-DAY AND MONTHLY TOTALS MEAN TOTAL	STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	MAXIMUM DAILY TOTALS EXTREME	YR	AVE MAX	STD DEV	MEDIAN
JAN 1	16	1.036	0.793	0.900	2.60	53	0.05	58	1.40	60	0.491	0.405	0.385
JAN 11	16	1.417	1.205	1.175	4.04	54	0.00	65	1.40	64	0.540	0.386	0.435
JAN 21	17	1.468	1.323	1.430	4.45	65	0.00	66	2.45	63	0.631	0.633	0.670
FEB 1	18	1.163	0.795	1.155	2.99	63	0.00	54	2.11	63	0.674	0.572	0.495
FEB 11	17	0.932	0.721	0.840	2.87	54	0.01	55	1.08	54	0.389	0.270	0.400
FEB 21	17	0.674	0.722	0.300	2.72	57	0.00	67	0.85	57	0.295	0.245	0.210
MAR 1	18	0.939	0.649	1.050	2.43	60	0.00	65	0.96	55	0.413	0.269	0.380
MAR 11	18	0.766	0.558	0.705	2.10	57	0.04	62	1.12	57	0.357	0.257	0.320
MAR 21	18	1.039	0.582	0.900	2.36	63	0.21	49	1.18	61	0.489	0.293	0.460
APR 1	18	0.732	0.668	0.495	2.09	58	0.00	49	1.45	58	0.403	0.398	0.260
APR 11	18	1.069	0.951	0.595	3.17	65	0.05	56	1.38	65	0.476	0.335	0.380
APR 21	18	0.683	0.423	0.610	1.41	59	0.00	52	0.80	62	0.357	0.235	0.350
MAY 1	18	0.975	0.596	0.860	2.67	63	0.02	52	1.10	49	0.501	0.272	0.440
MAY 11	18	0.672	0.670	0.490	2.71	57	0.00	54	0.75	58	0.296	0.208	0.310
MAY 21	18	0.977	0.697	0.830	2.46	59	0.00	50	0.97	59	0.436	0.299	0.310
JUN 1	18	1.010	0.816	0.850	2.78	63	0.00	65	1.36	63	0.431	0.314	0.415
JUN 11	18	0.709	0.438	0.610	1.58	64	0.02	59	1.05	60	0.426	0.270	0.400
JUN 21	18	0.702	0.655	0.425	2.25	52	0.00	61	0.80	63	0.356	0.251	0.270
JUL 1	19	0.360	0.391	0.290	1.16	55	0.00	60	0.80	58	0.220	0.225	0.170
JUL 11	19	0.236	0.449	0.080	1.73	54	0.00	66	1.73	54	0.186	0.401	0.050
JUL 21	19	0.272	0.321	0.160	0.86	64	0.00	66	0.80	51	0.193	0.245	0.110
AUG 1	19	0.355	0.424	0.190	1.45	63	0.00	66	1.27	63	0.273	0.333	0.160
AUG 11	19	0.324	0.369	0.160	1.23	54	0.00	67	0.60	65	0.217	0.216	0.120
AUG 21	19	0.548	0.588	0.350	1.87	56	0.00	55	0.98	51	0.308	0.297	0.200
SEP 1	18	0.334	0.359	0.300	1.10	61	0.00	62	0.95	65	0.249	0.302	0.130
SEP 11	18	0.751	0.591	0.620	1.85	59	0.00	53	0.90	66	0.360	0.252	0.325
SEP 21	18	0.381	0.404	0.255	1.19	59	0.00	65	1.14	67	0.272	0.308	0.200
OCT 1	18	0.779	0.846	0.545	2.99	62	0.00	54	1.20	62	0.383	0.383	0.285
OCT 11	18	0.856	0.954	0.800	4.08	62	0.00	53	1.82	62	0.458	0.446	0.390
OCT 21	18	0.711	0.811	0.395	2.99	56	0.00	65	0.80	51	0.315	0.288	0.255
NOV 1	17	0.580	0.607	0.410	2.18	58	0.00	54	0.60	58	0.270	0.199	0.220
NOV 11	17	1.050	0.744	0.790	2.51	60	0.11	59	1.00	55	0.474	0.250	0.460
NOV 21	17	0.971	0.864	0.850	2.88	61	0.00	56	1.24	60	0.391	0.346	0.310
DEC 1	17	0.899	0.714	0.660	2.43	66	0.00	59	1.20	51	0.421	0.366	0.280
DEC 11	16	1.066	0.834	0.805	3.21	55	0.04	59	1.20	55	0.480	0.331	0.425
DEC 21	16	1.567	2.322	0.895	8.97	64	0.10	63	2.62	64	0.618	0.730	0.385
MONTH													
JAN	16	4.013	2.118	4.030	7.62	54	1.18	61	2.45	63	1.005	0.528	0.840
FEB	17	2.819	0.978	2.930	4.90	61	0.90	64	2.11	63	0.858	0.492	0.770
MAR	18	2.744	1.104	2.660	4.90	60	0.92	49	1.18	61	0.653	0.276	0.570
APR	18	2.485	1.499	2.415	5.77	65	0.15	56	1.45	58	0.667	0.391	0.610
MAY	18	2.624	1.323	2.600	4.92	57	0.72	66	1.10	49	0.622	0.275	0.570
JUN	18	2.421	1.321	1.955	6.12	63	0.70	49	1.36	63	0.658	0.249	0.630
JUL	19	0.868	0.800	0.710	2.54	58	0.00	49	1.73	54	0.404	0.412	0.330
AUG	19	1.227	0.759	1.040	2.29	64	0.07	67	1.27	63	0.502	0.334	0.510
SEP	18	1.465	0.994	1.300	3.41	59	0.09	53	1.14	67	0.500	0.321	0.455
OCT	18	2.345	1.931	1.945	7.07	62	0.00	49	1.82	62	0.633	0.427	0.595
NOV	17	2.601	1.457	2.440	4.92	62	0.73	52	1.24	60	0.601	0.268	0.520
DEC	16	3.582	3.035	2.525	12.41	64	0.95	59	2.62	64	0.871	0.647	0.595

(con.)

P R E C I P I T A T I O N BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 101663 CHALLIS YRS 1951-1980

PERIOD BEGINS	NO. YRS	10-DAY AND MONTHLY TOTALS MEAN TOTAL	STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	MAXIMUM DAILY TOTALS EXTREME	YR	AVE MAX	STD DEV	MEDIAN
JAN 1	30	0.149	0.158	0.090	0.49	53	0.00	74	0.31	53	0.091	0.091	0.065
JAN 11	30	0.224	0.261	0.115	0.95	69	0.00	77	0.83	80	0.139	0.184	0.070
JAN 21	30	0.181	0.190	0.100	0.64	69	0.00	77	0.47	65	0.102	0.112	0.070
FEB 1	30	0.141	0.223	0.050	0.86	63	0.00	79	0.74	63	0.107	0.173	0.040
FEB 11	30	0.130	0.144	0.070	0.53	79	0.00	77	0.33	62	0.080	0.087	0.060
FEB 21	30	0.091	0.102	0.065	0.44	76	0.00	72	0.30	67	0.069	0.076	0.050
MAR 1	30	0.177	0.216	0.125	1.07	74	0.00	65	0.54	74	0.118	0.128	0.070
MAR 11	30	0.106	0.126	0.075	0.50	79	0.00	78	0.48	79	0.081	0.110	0.060
MAR 21	30	0.119	0.107	0.090	0.33	74	0.00	62	0.24	60	0.079	0.067	0.060
APR 1	30	0.172	0.241	0.060	0.85	63	0.00	77	0.70	63	0.121	0.187	0.050
APR 11	30	0.129	0.244	0.055	1.30	73	0.00	74	0.90	73	0.098	0.176	0.040
APR 21	30	0.280	0.283	0.165	0.94	60	0.00	77	0.47	53	0.169	0.156	0.135
MAY 1	30	0.299	0.300	0.250	1.17	80	0.00	74	0.85	58	0.180	0.179	0.175
MAY 11	30	0.444	0.548	0.275	2.25	57	0.00	79	0.99	61	0.247	0.231	0.200
MAY 21	30	0.371	0.349	0.230	1.17	62	0.00	75	1.00	62	0.220	0.219	0.170
JUN 1	30	0.505	0.588	0.320	1.98	68	0.00	79	0.81	53	0.231	0.232	0.150
JUN 11	30	0.341	0.320	0.220	1.08	55	0.00	71	0.99	74	0.189	0.191	0.135
JUN 21	30	0.326	0.330	0.235	1.08	63	0.00	74	0.74	63	0.209	0.211	0.135
JUL 1	30	0.200	0.254	0.070	0.81	55	0.00	76	0.69	55	0.136	0.179	0.045
JUL 11	30	0.157	0.293	0.050	1.34	54	0.00	80	0.70	54	0.097	0.150	0.040
JUL 21	30	0.178	0.227	0.100	1.13	77	0.00	80	0.71	77	0.119	0.148	0.070
AUG 1	30	0.192	0.227	0.105	0.89	74	0.00	80	0.39	74	0.129	0.133	0.070
AUG 11	30	0.208	0.296	0.040	1.10	68	0.00	80	0.75	74	0.118	0.173	0.040
AUG 21	30	0.181	0.198	0.135	0.70	51	0.00	78	0.47	75	0.120	0.138	0.075
SEP 1	30	0.151	0.220	0.025	0.91	78	0.00	79	0.57	78	0.098	0.141	0.025
SEP 11	30	0.398	0.526	0.120	1.85	76	0.00	79	1.22	76	0.238	0.337	0.085
SEP 21	30	0.122	0.188	0.035	0.88	68	0.00	78	0.88	68	0.102	0.179	0.030
OCT 1	30	0.135	0.255	0.045	1.19	67	0.00	80	0.58	67	0.085	0.135	0.035
OCT 11	29	0.133	0.221	0.040	0.95	72	0.00	78	0.75	72	0.109	0.183	0.040
OCT 21	29	0.123	0.150	0.070	0.50	67	0.00	78	0.39	57	0.083	0.104	0.050
NOV 1	30	0.123	0.193	0.030	0.67	68	0.00	78	0.48	80	0.084	0.126	0.030
NOV 11	29	0.121	0.196	0.050	0.95	73	0.00	78	0.35	73	0.062	0.090	0.030
NOV 21	30	0.158	0.155	0.110	0.63	70	0.00	69	0.28	70	0.095	0.083	0.070
DEC 1	29	0.172	0.167	0.110	0.68	51	0.00	76	0.68	51	0.123	0.134	0.070
DEC 11	29	0.133	0.168	0.080	0.66	64	0.00	80	0.35	73	0.081	0.090	0.050
DEC 21	29	0.287	0.577	0.130	2.84	64	0.00	76	1.62	64	0.190	0.341	0.100
MONTH													
JAN	30	0.553	0.366	0.485	1.68	69	0.00	61	0.83	80	0.220	0.167	0.180
FEB	30	0.362	0.264	0.330	0.86	63	0.00	56	0.74	63	0.177	0.164	0.135
MAR	30	0.402	0.314	0.330	1.64	74	0.03	61	0.54	74	0.176	0.132	0.125
APR	30	0.581	0.455	0.480	1.70	67	0.00	74	0.90	73	0.278	0.213	0.280
MAY	30	1.114	0.823	1.030	3.49	57	0.10	54	1.00	62	0.383	0.237	0.305
JUN	30	1.172	0.743	1.035	3.83	63	0.00	60	0.99	74	0.410	0.212	0.390
JUL	30	0.535	0.435	0.430	1.75	54	0.00	66	0.71	77	0.249	0.198	0.235
AUG	30	0.581	0.428	0.475	1.64	74	0.02	64	0.75	74	0.247	0.158	0.235
SEP	30	0.671	0.689	0.395	2.28	76	0.01	51	1.22	76	0.308	0.319	0.205
OCT	29	0.397	0.480	0.240	1.79	67	0.00	78	0.75	72	0.169	0.197	0.120
NOV	29	0.406	0.346	0.320	1.67	73	0.00	59	0.48	80	0.170	0.120	0.140
DEC	29	0.592	0.717	0.380	3.72	64	0.00	76	1.62	64	0.275	0.329	0.190

(con.)

P R E C I P I T A T I O N BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 101932 COBALT YRS 1962-1981

PERIOD BEGINS	NO. YRS	10-DAY AND MONTHLY TOTALS MEAN TOTAL	STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	MAXIMUM DAILY TOTALS EXTREME	YR	AVE MAX	STD DEV	MEDIAN
JAN 1	20	0.547	0.403	0.470	1.52	71	0.00	81	0.62	76	0.257	0.162	0.255
JAN 11	20	0.606	0.481	0.510	1.57	71	0.03	81	0.88	66	0.331	0.264	0.260
JAN 21	20	0.529	0.580	0.260	1.78	65	0.00	77	0.78	75	0.241	0.259	0.120
FEB 1	20	0.334	0.415	0.300	1.92	63	0.00	81	1.43	63	0.234	0.309	0.165
FEB 11	20	0.441	0.393	0.355	1.56	81	0.00	77	0.56	68	0.214	0.149	0.220
FEB 21	20	0.276	0.219	0.235	0.73	72	0.00	73	0.38	76	0.158	0.108	0.150
MAR 1	19	0.386	0.432	0.190	1.73	74	0.00	81	0.53	72	0.202	0.169	0.160
MAR 11	19	0.382	0.240	0.360	0.93	67	0.02	78	0.36	70	0.201	0.111	0.220
MAR 21	19	0.341	0.252	0.310	0.97	71	0.00	64	0.43	72	0.176	0.120	0.180
APR 1	18	0.650	0.407	0.515	1.67	63	0.22	78	0.90	67	0.354	0.231	0.290
APR 11	18	0.402	0.374	0.390	1.60	67	0.00	80	0.92	67	0.231	0.216	0.215
APR 21	18	0.733	0.628	0.670	2.47	71	0.00	68	1.67	71	0.380	0.377	0.360
MAY 1	17	0.607	0.369	0.610	1.50	80	0.03	69	0.86	81	0.337	0.210	0.330
MAY 11	17	0.662	0.529	0.570	1.65	78	0.00	79	0.62	78	0.308	0.219	0.270
MAY 21	17	0.741	0.627	0.480	2.41	80	0.03	63	1.04	81	0.389	0.275	0.310
JUN 1	17	0.741	0.636	0.520	2.14	63	0.08	75	1.03	63	0.351	0.265	0.290
JUN 11	17	0.894	0.487	1.000	1.59	62	0.03	74	1.13	79	0.466	0.295	0.420
JUN 21	17	0.644	0.772	0.400	2.61	70	0.00	81	1.37	70	0.319	0.373	0.300
JUL 1	17	0.498	0.535	0.370	1.59	69	0.00	79	0.95	69	0.281	0.295	0.220
JUL 11	17	0.401	0.392	0.200	1.10	67	0.00	81	0.82	68	0.287	0.291	0.140
JUL 21	17	0.438	0.526	0.240	1.75	75	0.00	79	0.98	75	0.275	0.278	0.170
AUG 1	19	0.254	0.281	0.210	1.00	77	0.00	81	0.74	77	0.165	0.182	0.120
AUG 11	19	0.497	0.597	0.410	2.26	68	0.00	77	0.89	68	0.269	0.268	0.200
AUG 21	19	0.380	0.351	0.270	1.19	75	0.00	81	0.55	73	0.247	0.220	0.200
SEP 1	19	0.410	0.546	0.190	2.10	70	0.00	81	1.10	70	0.258	0.291	0.130
SEP 11	18	0.607	0.566	0.500	1.64	68	0.00	79	1.05	66	0.324	0.289	0.285
SEP 21	19	0.274	0.286	0.220	0.90	77	0.00	78	0.86	67	0.174	0.200	0.200
OCT 1	19	0.373	0.456	0.180	1.37	67	0.00	80	0.81	75	0.204	0.241	0.130
OCT 11	19	0.371	0.300	0.370	0.90	63	0.00	78	0.60	63	0.224	0.181	0.230
OCT 21	20	0.414	0.442	0.290	1.61	75	0.00	80	0.68	75	0.223	0.218	0.165
NOV 1	19	0.479	0.430	0.340	1.58	68	0.00	81	0.92	68	0.248	0.203	0.210
NOV 11	19	0.399	0.379	0.270	1.24	68	0.00	78	0.65	68	0.205	0.175	0.160
NOV 21	19	0.526	0.399	0.420	1.31	70	0.00	80	0.85	81	0.292	0.245	0.230
DEC 1	19	0.607	0.629	0.250	2.09	75	0.07	73	1.31	75	0.333	0.342	0.190
DEC 11	19	0.454	0.529	0.280	2.17	77	0.00	80	1.13	77	0.238	0.262	0.170
DEC 21	19	0.654	0.454	0.550	1.61	73	0.03	63	1.00	62	0.289	0.232	0.240
MONTH													
JAN	20	1.682	0.994	1.785	3.33	71	0.15	81	0.88	66	0.461	0.259	0.515
FEB	20	1.050	0.666	1.015	2.59	63	0.05	73	1.43	63	0.327	0.291	0.275
MAR	19	1.108	0.706	0.910	2.89	74	0.10	65	0.53	72	0.284	0.128	0.300
APR	18	1.784	0.982	1.425	3.36	67	0.49	77	1.67	71	0.515	0.351	0.410
MAY	17	2.011	1.142	1.630	4.42	80	0.72	73	1.04	81	0.502	0.231	0.520
JUN	17	2.278	1.038	2.000	5.21	63	0.43	74	1.37	70	0.672	0.299	0.630
JUL	17	1.336	0.884	1.060	3.30	75	0.00	79	0.98	75	0.568	0.267	0.600
AUG	19	1.131	0.768	0.970	3.34	68	0.13	69	0.89	68	0.444	0.206	0.520
SEP	18	1.268	0.873	1.475	2.68	70	0.07M	62	1.10	70	0.469	0.318	0.375
OCT	19	1.180	0.881	0.920	3.20	75	0.05	78	0.81	75	0.377	0.190	0.380
NOV	19	1.404	0.777	1.080	3.24	68	0.34	76	0.92	68	0.425	0.217	0.370
DEC	19	1.715	1.021	1.500	4.34	77	0.29	76	1.31	75	0.478	0.334	0.400

(con.)

P R E C I P I T A T I O N BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 102575 DIXIE YRS 1952-1980

			10-DAY AND MONTHLY TOTALS						MAXIMUM DAILY TOTALS				
PERIOD BEGINS	NO. YRS	MEAN TOTAL	STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	EXTREME	YR	AVE MAX	STD DEV	MEDIAN
JAN 1	28	1.145	0.880	0.930	3.15	69	0.00	58	0.90	69	0.365	0.258	0.300
JAN 11	28	1.666	1.152	1.260	4.65	53	0.15	65	1.41	72	0.577	0.381	0.475
JAN 21	28	1.533	1.407	1.120	6.40	65	0.00	77	1.47	65	0.479	0.348	0.460
FEB 1	28	0.942	0.640	0.885	2.29	74	0.00	54	1.11	79	0.411	0.279	0.385
FEB 11	28	1.123	0.701	1.145	2.46	76	0.00	57	1.27	68	0.385	0.256	0.390
FEB 21	28	0.734	0.555	0.670	2.59	72	0.03	67	0.57	57	0.314	0.148	0.310
MAR 1	28	1.070	0.725	1.015	3.25	74	0.00	65	1.14	67	0.439	0.267	0.400
MAR 11	28	0.974	0.496	0.930	2.36	67	0.34	79	0.90	64	0.444	0.190	0.405
MAR 21	28	1.035	0.528	0.980	2.37	64	0.16	78	1.27	64	0.444	0.225	0.410
APR 1	28	0.888	0.493	0.875	2.33	54	0.10	56	1.24	54	0.417	0.238	0.365
APR 11	28	0.889	0.656	0.725	2.23	60	0.00	56	0.98	67	0.410	0.264	0.345
APR 21	28	0.743	0.421	0.715	1.71	75	0.00	77	0.94	75	0.349	0.220	0.295
MAY 1	28	0.877	0.553	0.890	1.94	75	0.03	66	0.80	60	0.398	0.222	0.365
MAY 11	28	0.830	0.800	0.730	4.18	57	0.00	79	1.09	57	0.375	0.247	0.385
MAY 21	28	0.992	0.515	0.880	1.93	80	0.24	75	1.02	60	0.453	0.243	0.430
JUN 1	28	1.070	0.804	0.865	2.68	58	0.00	73	1.63	69	0.504	0.349	0.415
JUN 11	28	0.861	0.563	0.805	2.11	73	0.00	74	1.06	73	0.413	0.234	0.390
JUN 21	28	0.856	0.793	0.575	3.32	63	0.00	61	1.09	55	0.426	0.315	0.360
JUL 1	29	0.450	0.491	0.300	2.16	80	0.00	76	1.00	80	0.278	0.274	0.200
JUL 11	29	0.293	0.367	0.130	1.42	76	0.00	79	0.78	54	0.205	0.224	0.130
JUL 21	29	0.322	0.391	0.140	1.43	64	0.00	71	1.01	64	0.206	0.238	0.140
AUG 1	28	0.332	0.294	0.280	0.95	60	0.00	79	0.95	60	0.245	0.227	0.220
AUG 11	28	0.491	0.587	0.235	2.14	68	0.00	73	1.14	74	0.292	0.320	0.195
AUG 21	28	0.587	0.699	0.350	2.86	56	0.00	70	1.35	56	0.324	0.342	0.235
SEP 1	29	0.427	0.577	0.220	2.78	70	0.00	79	1.40	70	0.262	0.321	0.170
SEP 11	29	0.764	0.667	0.590	2.34	80	0.00	79	0.88	80	0.359	0.263	0.380
SEP 21	29	0.457	0.643	0.170	2.50	77	0.00	78	1.14	59	0.242	0.266	0.140
OCT 1	29	0.664	0.755	0.470	2.69	62	0.00	80	1.37	62	0.356	0.380	0.330
OCT 11	29	0.583	0.572	0.310	2.30	68	0.00	78	1.11	68	0.336	0.293	0.220
OCT 21	29	0.921	0.855	0.770	3.64	75	0.00	65	1.23	75	0.416	0.369	0.290
NOV 1	28	0.801	0.786	0.570	3.65	73	0.00	52	1.34	73	0.364	0.309	0.260
NOV 11	28	0.947	0.552	0.770	2.23	60	0.19	76	1.12	62	0.424	0.233	0.360
NOV 21	28	1.248	0.916	1.225	3.57	55	0.00	69	1.30	61	0.514	0.343	0.475
DEC 1	29	1.324	0.936	1.130	4.42	75	0.05	65	1.42	75	0.517	0.318	0.440
DEC 11	29	1.081	0.707	1.010	2.66	64	0.00	76	0.91	57	0.412	0.258	0.340
DEC 21	29	1.406	1.121	1.250	6.02	64	0.30	62	1.70	64	0.523	0.317	0.510
MONTH													
JAN	28	4.344	2.354	3.550	8.17	71	1.38	77	1.47	65	0.747	0.362	0.700
FEB	28	2.799	1.079	2.760	5.45	72	0.71	73	1.27	68	0.584	0.236	0.540
MAR	28	3.079	1.367	3.075	6.67	74	0.89	65	1.27	64	0.610	0.234	0.555
APR	28	2.520	1.018	2.400	4.18	75	0.20	56	1.24	54	0.606	0.239	0.560
MAY	28	2.698	1.173	2.375	6.45	57	1.28	74	1.09	57	0.592	0.214	0.585
JUN	28	2.787	1.336	2.285	6.44	63	0.80	60	1.63	69	0.714	0.297	0.655
JUL	29	1.065	0.715	1.010	2.67	77	0.03	66	1.01	64	0.440	0.273	0.430
AUG	28	1.410	1.128	0.945	3.69	56	0.00	55	1.35	56	0.518	0.335	0.515
SEP	29	1.648	1.324	1.520	4.94	59	0.00	57	1.40	70	0.491	0.324	0.520
OCT	29	2.168	1.496	1.890	5.96	75	0.06	78	1.37	62	0.646	0.349	0.570
NOV	28	2.996	1.637	2.955	7.28	73	0.54	52	1.34	73	0.685	0.327	0.645
DEC	29	3.811	1.898	4.040	9.76	64	0.86	59	1.70	64	0.706	0.349	0.750

(con.)

P R E C I P I T A T I O N BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 105708 MC CALL YRS 1951-1980

PERIOD BEGINS	NO. YRS	10-DAY AND MONTHLY TOTALS MEAN TOTAL	STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	MAXIMUM DAILY TOTALS EXTREME	YR	AVE MAX	STD DEV	MEDIAN
JAN 1	30	1.208	0.990	0.905	3.89	66	0.00	58	1.41	53	0.542	0.379	0.525
JAN 11	30	1.652	1.162	1.375	4.55	74	0.00	65	1.90	56	0.616	0.428	0.525
JAN 21	30	1.425	1.295	0.920	4.86	65	0.00	77	1.51	61	0.573	0.418	0.415
FEB 1	30	0.922	0.728	0.875	2.70	51	0.00	76	1.02	62	0.421	0.291	0.440
FEB 11	30	1.156	0.996	0.930	4.09	54	0.00	77	1.29	79	0.480	0.357	0.395
FEB 21	30	0.757	0.692	0.625	2.81	57	0.00	64	1.50	57	0.429	0.336	0.370
MAR 1	30	0.930	0.827	0.860	4.14	51	0.00	65	1.53	51	0.455	0.372	0.385
MAR 11	30	0.832	0.554	0.670	1.90	53	0.00	65	0.83	64	0.400	0.197	0.400
MAR 21	30	0.916	0.590	0.780	2.33	63	0.16	73	1.31	63	0.457	0.271	0.370
APR 1	30	0.736	0.597	0.635	2.32	63	0.00	59	1.11	63	0.394	0.267	0.375
APR 11	30	0.665	0.611	0.420	2.29	65	0.00	80	0.90	72	0.347	0.265	0.310
APR 21	30	0.669	0.537	0.575	1.82	67	0.00	77	0.82	59	0.361	0.263	0.330
MAY 1	30	0.731	0.559	0.690	1.81	63	0.00	76	0.84	63	0.366	0.253	0.425
MAY 11	30	0.664	0.590	0.605	2.90	57	0.00	79	0.75	57	0.324	0.230	0.275
MAY 21	30	0.745	0.578	0.705	1.82	62	0.00	69	0.91	71	0.365	0.244	0.390
JUN 1	30	0.845	0.888	0.535	3.36	53	0.00	79	1.52	53	0.421	0.373	0.350
JUN 11	30	0.646	0.532	0.515	2.17	64	0.00	59	1.55	70	0.385	0.323	0.350
JUN 21	30	0.623	0.737	0.380	2.93	71	0.00	61	1.32	71	0.351	0.357	0.265
JUL 1	30	0.206	0.292	0.105	1.22	78	0.00	76	0.59	51	0.141	0.174	0.085
JUL 11	30	0.193	0.373	0.040	1.74	76	0.00	79	1.15	76	0.147	0.256	0.030
JUL 21	30	0.170	0.269	0.030	1.17	77	0.00	80	0.93	77	0.126	0.203	0.025
AUG 1	30	0.292	0.486	0.030	2.03	76	0.00	79	1.31	53	0.200	0.307	0.030
AUG 11	30	0.391	0.676	0.030	2.93	68	0.00	77	0.78	68	0.176	0.247	0.030
AUG 21	30	0.407	0.501	0.125	1.92	77	0.00	74	0.87	75	0.224	0.245	0.120
SEP 1	30	0.331	0.604	0.080	2.84	70	0.00	79	1.42	70	0.221	0.336	0.065
SEP 11	30	0.778	0.983	0.545	4.85	59	0.00	79	1.37	59	0.397	0.338	0.360
SEP 21	30	0.391	0.505	0.235	1.77	67	0.00	78	1.77	67	0.259	0.367	0.120
OCT 1	30	0.596	0.821	0.240	2.86	51	0.00	80	1.62	75	0.317	0.399	0.170
OCT 11	30	0.685	0.942	0.420	4.40	62	0.00	78	1.83	62	0.361	0.371	0.300
OCT 21	30	0.740	0.796	0.550	3.32	56	0.00	65	1.13	56	0.348	0.310	0.280
NOV 1	30	0.800	0.773	0.605	3.36	73	0.00	56	0.93	73	0.374	0.261	0.375
NOV 11	30	0.982	1.005	0.635	4.13	73	0.00	59	1.10	60	0.416	0.270	0.395
NOV 21	30	1.106	0.851	0.880	2.66	77	0.00	76	1.20	77	0.443	0.298	0.510
DEC 1	30	1.266	1.035	1.030	3.68	80	0.00	60	1.47	66	0.546	0.385	0.455
DEC 11	30	1.076	0.834	0.925	4.14	77	0.00	76	1.62	77	0.512	0.359	0.470
DEC 21	30	1.513	1.437	1.155	7.07	64	0.00	62	2.24	64	0.645	0.444	0.565
MONTH													
JAN	30	4.285	1.965	4.060	8.45	65	0.90	77	1.90	56	0.960	0.372	0.955
FEB	30	2.835	1.246	2.875	5.62	75	0.62	64	1.50	57	0.760	0.318	0.690
MAR	30	2.678	1.155	2.610	5.56	51	0.32	65	1.53	51	0.660	0.343	0.535
APR	30	2.070	1.137	2.055	4.19	78	0.27	52	1.11	63	0.590	0.222	0.630
MAY	30	2.139	1.113	1.890	4.82	57	0.44	58	0.91	71	0.557	0.189	0.550
JUN	30	2.114	1.327	1.820	5.57	64	0.29	60	1.55	70	0.671	0.347	0.610
JUL	30	0.569	0.605	0.305	2.43	76	0.00	69	1.15	76	0.294	0.282	0.205
AUG	30	1.090	1.008	0.890	3.30	75	0.00	70	1.31	53	0.415	0.318	0.435
SEP	30	1.500	1.386	1.170	6.43	59	0.00	53	1.77	67	0.582	0.419	0.535
OCT	30	2.021	1.824	1.420	6.47	51	0.05	78	1.83	62	0.588	0.415	0.535
NOV	30	2.888	1.850	2.650	9.25	73	0.36	76	1.20	77	0.639	0.221	0.615
DEC	30	3.854	2.043	3.730	8.75	64	0.81	76	2.24	64	0.937	0.376	0.875

(con.)

P R E C I P I T A T I O N BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 107706 RIGGINS YRS 1951-1980

PERIOD BEGINS	NO. YRS	MEAN TOTAL	STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	MAXIMUM DAILY TOTALS EXTREME	YR	AVE MAX	STD DEV	MEDIAN
		10-DAY AND MONTHLY TOTALS											
JAN 1	28	0.460	0.462	0.310	2.03	76	0.00	79	0.67	62	0.246	0.199	0.195
JAN 11	27	0.595	0.376	0.470	1.34	74	0.00	61	0.63	73	0.292	0.172	0.250
JAN 21	28	0.453	0.681	0.220	3.41	65	0.00	77	1.58	65	0.262	0.343	0.125
FEB 1	29	0.273	0.285	0.140	0.85	52	0.00	77	0.73	52	0.153	0.172	0.100
FEB 11	29	0.486	0.427	0.380	2.15	59	0.00	77	0.65	59	0.253	0.170	0.230
FEB 21	28	0.402	0.373	0.270	1.74	56	0.00	67	1.25	56	0.241	0.247	0.190
MAR 1	29	0.422	0.363	0.310	1.28	70	0.00	65	0.60	74	0.222	0.178	0.180
MAR 11	29	0.584	0.423	0.480	1.78	66	0.09	56	1.01	66	0.355	0.207	0.310
MAR 21	29	0.575	0.318	0.520	1.15	59	0.00	54	0.57	74	0.297	0.141	0.300
APR 1	28	0.679	0.467	0.655	2.15	78	0.00	60	1.00	78	0.347	0.229	0.350
APR 11	28	0.569	0.449	0.410	1.58	60	0.00	51	0.74	54	0.286	0.195	0.305
APR 21	28	0.553	0.402	0.555	1.17	78	0.00	77	0.90	74	0.309	0.233	0.250
MAY 1	30	0.695	0.526	0.555	1.78	52	0.00	58	1.00	52	0.360	0.274	0.270
MAY 11	30	0.623	0.595	0.500	2.76	57	0.00	79	0.85	69	0.319	0.261	0.260
MAY 21	30	0.686	0.497	0.625	1.86	54	0.00	58	1.04	60	0.382	0.262	0.375
JUN 1	30	0.772	0.625	0.695	2.26	64	0.00	79	1.23	54	0.436	0.315	0.450
JUN 11	30	0.569	0.508	0.320	1.79	65	0.00	59	1.00	56	0.312	0.227	0.290
JUN 21	30	0.504	0.510	0.370	1.83	52	0.00	77	1.10	58	0.295	0.318	0.200
JUL 1	30	0.298	0.595	0.095	3.02	78	0.00	76	2.49	78	0.222	0.459	0.095
JUL 11	30	0.256	0.338	0.085	1.02	76	0.00	79	0.75	74	0.176	0.208	0.065
JUL 21	30	0.179	0.243	0.050	1.03	77	0.00	74	0.43	77	0.122	0.136	0.050
AUG 1	30	0.210	0.335	0.025	1.24	60	0.00	80	1.24	60	0.149	0.256	0.020
AUG 11	30	0.284	0.487	0.065	2.16	78	0.00	77	1.25	78	0.169	0.281	0.055
AUG 21	30	0.460	0.530	0.250	2.02	75	0.00	74	1.00	56	0.246	0.280	0.190
SEP 1	30	0.227	0.351	0.145	1.71	70	0.00	77	0.94	70	0.164	0.212	0.110
SEP 11	30	0.544	0.586	0.430	1.99	59	0.00	79	0.96	55	0.302	0.283	0.225
SEP 21	30	0.318	0.477	0.135	1.98	59	0.00	78	1.00	59	0.208	0.255	0.095
OCT 1	28	0.434	0.538	0.230	2.10	62	0.00	80	1.18	75	0.292	0.334	0.190
OCT 11	28	0.507	0.660	0.280	2.71	62	0.00	77	1.60	68	0.314	0.390	0.210
OCT 21	28	0.454	0.372	0.400	1.20	51	0.00	65	0.73	77	0.311	0.236	0.325
NOV 1	28	0.371	0.383	0.315	1.93	73	0.00	72	0.72	60	0.227	0.201	0.185
NOV 11	27	0.500	0.433	0.420	1.80	73	0.00	80	0.90	72	0.276	0.214	0.230
NOV 21	28	0.475	0.515	0.375	2.23	62	0.00	69	0.98	62	0.240	0.247	0.210
DEC 1	27	0.584	0.540	0.400	1.59	66	0.00	65	1.20	75	0.345	0.331	0.240
DEC 11	27	0.447	0.382	0.380	1.51	58	0.00	80	1.15	58	0.257	0.247	0.220
DEC 21	27	0.600	0.582	0.490	2.45	64	0.00	62	1.60	69	0.337	0.351	0.270
MONTH													
JAN	27	1.467	0.931	1.200	4.63	65	0.41	79	1.58	65	0.454	0.297	0.350
FEB	28	1.154	0.578	1.075	2.29	59	0.23	77	1.25	56	0.399	0.227	0.350
MAR	29	1.581	0.663	1.580	2.91	74	0.48	69	1.01	66	0.448	0.176	0.430
APR	28	1.800	0.931	1.900	4.15	78	0.30	51	1.00	78	0.486	0.197	0.450
MAY	30	2.004	0.914	1.945	4.22	57	0.25	66	1.04	60	0.567	0.243	0.525
JUN	30	1.846	0.932	1.495	4.13	64	0.37	60	1.23	54	0.635	0.252	0.565
JUL	30	0.734	0.725	0.445	3.28	78	0.02	69	2.49	78	0.376	0.440	0.310
AUG	30	0.954	0.780	0.705	2.39	65	0.00	70	1.25	78	0.405	0.348	0.335
SEP	30	1.088	0.970	0.955	4.18	59	0.03	74	1.00	59	0.428	0.289	0.435
OCT	28	1.395	1.059	1.080	4.81	62	0.15	74	1.60	68	0.564	0.343	0.505
NOV	27	1.377	0.860	1.270	4.24	73	0.45	74	0.98	62	0.421	0.236	0.350
DEC	26	1.623	0.860	1.700	3.45	64	0.20	76	1.60	69	0.599	0.372	0.485

(con.)

PRECIPITATION BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 108076 SALMON - SALMON 1 N YRS 1951-1980

PERIOD BEGINS	NO. YRS	MEAN TOTAL	10-DAY AND MONTHLY TOTALS STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	MAXIMUM DAILY TOTALS EXTREME	YR	AVE MAX	STD DEV	MEDIAN
JAN 1	30	0.203	0.210	0.155	0.93	76	0.00	70	0.44	76	0.105	0.102	0.070
JAN 11	30	0.287	0.295	0.190	1.38	56	0.00	61	0.76	56	0.172	0.169	0.110
JAN 21	30	0.261	0.262	0.160	0.93	65	0.00	71	0.55	67	0.134	0.122	0.090
FEB 1	30	0.219	0.276	0.120	1.23	51	0.00	77	0.63	60	0.141	0.166	0.090
FEB 11	30	0.207	0.155	0.215	0.60	62	0.00	77	0.36	52	0.119	0.093	0.100
FEB 21	30	0.127	0.117	0.085	0.42	78	0.00	70	0.20	79	0.079	0.064	0.065
MAR 1	30	0.213	0.231	0.145	0.94	74	0.00	69	0.38	72	0.106	0.106	0.075
MAR 11	30	0.169	0.150	0.165	0.61	57	0.00	68	0.55	57	0.117	0.118	0.085
MAR 21	30	0.158	0.139	0.125	0.52	52	0.00	69	0.39	65	0.098	0.089	0.080
APR 1	30	0.245	0.308	0.105	1.27	67	0.00	66	0.84	67	0.165	0.205	0.080
APR 11	30	0.197	0.196	0.140	0.76	67	0.00	80	0.50	58	0.127	0.129	0.075
APR 21	30	0.377	0.450	0.280	2.22	71	0.00	69	1.50	71	0.229	0.296	0.125
MAY 1	30	0.398	0.385	0.360	1.59	80	0.00	69	0.73	80	0.210	0.191	0.170
MAY 11	30	0.401	0.372	0.265	1.20	55	0.00	71	0.61	55	0.217	0.186	0.175
MAY 21	30	0.542	0.443	0.405	1.61	80	0.04	75	0.57	53	0.246	0.161	0.220
JUN 1	28	0.645	0.654	0.530	2.64	64	0.00	79	1.10	53	0.348	0.320	0.245
JUN 11	29	0.532	0.383	0.530	1.35	64	0.00	52	1.01	79	0.290	0.225	0.250
JUN 21	29	0.532	0.565	0.330	1.81	52	0.00	77	0.95	63	0.302	0.313	0.180
JUL 1	30	0.281	0.331	0.150	1.48	69	0.00	79	0.78	69	0.161	0.184	0.080
JUL 11	30	0.201	0.258	0.075	1.00	76	0.00	80	0.68	76	0.129	0.175	0.060
JUL 21	30	0.246	0.364	0.125	1.59	77	0.00	68	0.81	77	0.164	0.194	0.120
AUG 1	30	0.212	0.217	0.160	0.74	77	0.00	80	0.70	60	0.141	0.158	0.115
AUG 11	30	0.291	0.385	0.150	1.84	68	0.00	77	0.72	65	0.168	0.170	0.120
AUG 21	30	0.275	0.272	0.180	0.88	75	0.00	74	0.72	60	0.186	0.192	0.135
SEP 1	30	0.182	0.262	0.020	0.94	70	0.00	79	0.80	70	0.113	0.186	0.020
SEP 11	30	0.359	0.435	0.235	1.81	66	0.00	79	1.19	66	0.211	0.258	0.125
SEP 21	30	0.124	0.179	0.045	0.73	59	0.00	79	0.46	67	0.073	0.111	0.035
OCT 1	29	0.193	0.347	0.060	1.56	67	0.00	80	0.73	67	0.121	0.194	0.050
OCT 11	30	0.190	0.204	0.120	0.65	72	0.00	77	0.54	75	0.124	0.134	0.070
OCT 21	30	0.196	0.211	0.135	0.68	74	0.00	78	0.50	74	0.112	0.127	0.080
NOV 1	30	0.270	0.316	0.180	1.18	68	0.00	65	1.02	70	0.173	0.245	0.090
NOV 11	30	0.187	0.172	0.130	0.68	62	0.00	76	0.40	62	0.099	0.089	0.080
NOV 21	30	0.241	0.298	0.120	1.10	70	0.00	60	0.42	71	0.117	0.124	0.065
DEC 1	30	0.226	0.265	0.110	1.01	75	0.00	68	0.72	75	0.122	0.162	0.060
DEC 11	30	0.271	0.375	0.130	1.80	77	0.00	80	1.05	77	0.157	0.216	0.085
DEC 21	30	0.309	0.323	0.195	1.31	64	0.01	63	0.90	55	0.162	0.179	0.115
MONTH													
JAN	30	0.751	0.415	0.650	1.72	56	0.17	61	0.76	56	0.260	0.150	0.210
FEB	30	0.553	0.340	0.545	1.32	51	0.00	70	0.63	60	0.205	0.145	0.180
MAR	30	0.540	0.384	0.440	1.41	74	0.00	68	0.55	57	0.188	0.120	0.170
APR	30	0.819	0.635	0.715	2.57	67	0.10	74	1.50	71	0.347	0.299	0.275
MAY	30	1.341	0.723	1.185	3.65	80	0.45	73	0.73	80	0.387	0.159	0.370
JUN	28	1.704	0.924	1.775	4.32	64	0.15	60	1.10	53	0.577	0.285	0.585
JUL	30	0.728	0.640	0.605	2.50	77	0.01	68	0.81	77	0.302	0.234	0.255
AUG	30	0.777	0.543	0.740	2.13	68	0.06	55	0.72	65	0.291	0.184	0.245
SEP	30	0.665	0.585	0.510	1.84	66	0.00	79	1.19	66	0.270	0.272	0.190
OCT	29	0.587	0.573	0.390	2.40	67	0.00	52	0.73	67	0.220	0.191	0.180
NOV	30	0.697	0.529	0.590	2.48	70	0.08	52	1.02	70	0.251	0.223	0.180
DEC	30	0.806	0.626	0.640	2.74	77	0.06	76	1.05	77	0.291	0.243	0.220

(con.)

P R E C I P I T A T I O N BY 10 (OR 11)-DAY AND MONTHLY PERIODS

STATION NUMBER 109560 WARREN YRS 1960-1981

PERIOD BEGINS	NO. YRS	MEAN TOTAL	10-DAY AND MONTHLY TOTALS STD. DEV	MEDIAN	HIGHEST TOT.	YR	LOWEST TOT.	YR	I	MAXIMUM DAILY TOTALS EXTREME	YR	AVE MAX	STD DEV	MEDIAN
JAN 1	22	1.214	0.899	1.360	3.16	66	0.00	81	I	1.12	65	0.555	0.362	0.575
JAN 11	22	1.243	1.295	0.805	5.57	74	0.00	81	I	2.21	74	0.553	0.531	0.370
JAN 21	22	1.163	1.362	0.795	6.17	65	0.00	80	I	1.71	65	0.446	0.394	0.425
FEB 1	22	0.805	0.600	0.820	2.15	75	0.00	81	I	1.15	71	0.434	0.359	0.285
FEB 11	22	0.944	0.623	0.765	2.68	72	0.00	77	I	1.85	72	0.500	0.373	0.410
FEB 21	22	0.569	0.525	0.375	1.90	72	0.00	81	I	0.78	76	0.315	0.231	0.295
MAR 1	22	0.913	0.951	0.790	3.55	74	0.00	79	I	1.85	67	0.440	0.423	0.315
MAR 11	22	1.014	0.654	0.880	2.80	80	0.18	62	I	1.05	71	0.535	0.262	0.515
MAR 21	22	0.962	0.503	0.930	1.89	63	0.07	68	I	1.04	80	0.478	0.226	0.480
APR 1	22	0.810	0.437	0.730	1.85	80	0.20	73	I	0.68	68	0.386	0.147	0.395
APR 11	22	0.786	0.606	0.615	1.82	67	0.00	80	I	1.18	65	0.394	0.283	0.330
APR 21	22	0.729	0.428	0.785	1.63	71	0.00	79	I	1.19	71	0.438	0.283	0.360
MAY 1	22	0.869	0.677	0.875	2.29	60	0.00	74	I	0.96	61	0.382	0.277	0.355
MAY 11	22	0.776	0.523	0.795	1.60	69	0.00	79	I	0.78	76	0.330	0.215	0.350
MAY 21	22	1.032	0.609	1.025	2.16	81	0.00	75	I	1.29	62	0.555	0.326	0.520
JUN 1	22	0.995	0.726	1.020	2.76	64	0.00	79	I	2.30	81	0.533	0.498	0.460
JUN 11	22	0.936	0.745	0.680	2.52	73	0.14	72	I	1.38	73	0.464	0.326	0.400
JUN 21	22	0.748	0.926	0.455	3.43	63	0.00	81	I	1.14	63	0.362	0.363	0.300
JUL 1	22	0.426	0.607	0.145	2.32	78	0.00	76	I	0.92	80	0.256	0.315	0.130
JUL 11	22	0.302	0.413	0.140	1.74	76	0.00	81	I	0.97	76	0.226	0.283	0.130
JUL 21	22	0.350	0.504	0.145	1.77	79	0.00	81	I	1.18	79	0.228	0.313	0.105
AUG 1	22	0.307	0.403	0.200	1.81	65	0.00	81	I	1.29	65	0.232	0.285	0.185
AUG 11	22	0.632	0.788	0.380	2.86	74	0.00	77	I	1.32	74	0.310	0.335	0.235
AUG 21	22	0.436	0.524	0.175	1.73	77	0.00	81	I	0.66	64	0.193	0.194	0.140
SEP 1	22	0.448	0.769	0.125	3.41	70	0.00	81	I	1.21	70	0.268	0.345	0.115
SEP 11	22	0.846	0.652	0.905	2.51	80	0.00	81	I	0.82	70	0.377	0.234	0.390
SEP 21	22	0.481	0.506	0.340	1.82	77	0.00	75	I	0.92	81	0.303	0.315	0.165
OCT 1	22	0.710	0.793	0.520	2.55	67	0.00	80	I	1.32	67	0.364	0.362	0.230
OCT 11	22	0.768	0.999	0.420	4.50	62	0.00	78	I	2.45	62	0.489	0.555	0.360
OCT 21	22	0.747	0.615	0.655	2.50	61	0.00	65	I	0.98	61	0.382	0.255	0.405
NOV 1	22	0.726	0.700	0.545	2.70	73	0.00	81	I	2.16	80	0.456	0.462	0.380
NOV 11	22	1.000	0.943	0.730	3.61	81	0.00	80	I	0.98	62	0.428	0.298	0.365
NOV 21	22	1.108	0.697	1.035	2.77	81	0.00	69	I	0.91	67	0.430	0.235	0.380
DEC 1	22	1.049	0.898	0.740	2.62	70	0.08	79	I	1.31	77	0.489	0.393	0.340
DEC 11	22	0.912	0.695	0.735	2.86	77	0.00	76	I	1.55	74	0.476	0.377	0.330
DEC 21	22	1.300	1.207	1.120	5.67	64	0.19	63	I	1.74	71	0.579	0.418	0.510
MONTH									I					
JAN	22	3.619	2.277	3.060	8.68	65	0.73	79	I	2.21	74	0.859	0.493	0.820
FEB	22	2.317	1.056	1.920	4.86	72	0.66	73	I	1.85	72	0.700	0.370	0.635
MAR	22	2.888	1.569	2.785	6.12	67	0.60	65	I	1.85	67	0.704	0.362	0.610
APR	22	2.325	0.873	2.385	3.85	67	0.43	77	I	1.19	71	0.594	0.253	0.550
MAY	22	2.677	1.203	2.595	5.23	60	0.69	67	I	1.29	62	0.670	0.267	0.665
JUN	22	2.679	1.384	2.410	6.16	63	0.51	60	I	2.30	81	0.798	0.455	0.645
JUL	22	1.078	0.843	1.015	2.77	76	0.00	69	I	1.18	79	0.499	0.338	0.385
AUG	22	1.375	1.165	1.030	3.77	65	0.00	70	I	1.32	74	0.432	0.350	0.400
SEP	22	1.775	0.997	1.695	4.49	70	0.12	79	I	1.21	70	0.599	0.277	0.610
OCT	22	2.225	1.463	1.990	6.36	62	0.16	78	I	2.45	62	0.750	0.496	0.545
NOV	22	2.835	1.453	2.390	6.46	73	1.07	76	I	2.16	80	0.712	0.382	0.625
DEC	22	3.260	1.691	2.905	7.71	64	1.10	79	I	1.74	71	0.855	0.391	0.730

Table 17—Observed frequencies of daily precipitation amounts, at stations as in table 16

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 100835 BIG CREEK 1 S 1949-1967

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.01	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
JAN 1	160	463	363	269	156	106	88	56	44	19	19		
JAN 11	162	512	444	358	241	167	123	86	80	31	12		
JAN 21	187	471	385	310	198	144	112	91	80	32	11	11	5
FEB 1	178	410	348	287	180	118	79	56	39	34	22	11	6
FEB 11	170	482	406	288	176	124	76	41	24	6	6		
FEB 21	145	421	352	276	159	110	69	34	21	7			
MAR 1	180	406	383	328	178	122	67	39	22	11			
MAR 11	180	406	372	256	128	78	61	33	6	6	6		
MAR 21	198	409	384	323	187	91	66	40	25	15	10		
APR 1	180	383	300	250	133	56	22	22	22	22	11		
APR 11	180	383	350	283	222	128	78	56	39	22	17		
APR 21	180	372	294	228	122	72	67	33	17	6			
MAY 1	180	439	389	306	178	117	78	39	33	17	6		
MAY 11	180	339	278	222	139	100	50	17	6				
MAY 21	198	444	379	263	152	96	61	45	30	20			
JUN 1	180	461	378	317	189	128	83	50	33	6	6		
JUN 11	180	372	306	217	117	83	56	39	28	11	6		
JUN 21	180	356	267	189	128	83	67	44	22	6			
JUL 1	189	206	148	127	69	42	21	16	5	5			
JUL 11	190	147	68	42	32	21	16	11	11	5	5	5	
JUL 21	208	139	101	82	43	24	19	10	10	5			
AUG 1	190	195	126	95	47	37	26	21	16	5	5		
AUG 11	190	168	137	121	53	42	21	21	11				
AUG 21	209	263	187	129	86	53	43	29	19	14			
SEP 1	180	178	144	89	44	33	28	17	11	11			
SEP 11	180	300	261	217	172	117	72	28	11	11			
SEP 21	180	194	128	106	67	50	28	22	11	11	6		
OCT 1	180	278	250	183	133	89	56	44	33	28	22		
OCT 11	180	328	289	233	156	83	67	44	39	11	6	6	
OCT 21	198	298	242	162	121	71	61	56	20	5			
NOV 1	177	282	232	186	102	68	56	28	6				
NOV 11	170	471	371	288	206	124	94	65	47	18	6		
NOV 21	175	389	354	297	206	120	74	63	34	17	6		
DEC 1	170	471	376	306	159	76	53	47	35	18	12		
DEC 11	163	442	356	301	166	110	86	61	37	18	12		
DEC 21	176	443	369	284	188	131	119	85	57	45	34	17	11
MONTH													
JAN	509	481	397	312	198	139	108	79	69	28	14	4	2
FEB	493	438	369	284	172	118	75	45	28	16	10	4	2
MAR	558	407	380	303	165	97	65	38	18	11	5		
APR	540	380	315	254	159	85	56	37	26	17	9		
MAY	558	409	349	263	156	104	63	34	23	13	2		
JUN	540	396	317	241	144	98	69	44	28	7	4		
JUL	587	164	106	83	48	29	19	12	9	5	2	2	
AUG	589	211	151	115	63	44	31	24	15	7	2		
SEP	540	224	178	137	94	67	43	22	11	11	2		
OCT	558	301	260	192	136	81	61	48	30	14	9	2	
NOV	522	379	318	257	170	103	75	52	29	11	4		
DEC	509	452	367	297	171	106	86	65	43	28	20	6	4

(con.)

Table 17 (Con.)

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101663 CHALLIS 1951-1980

PERIOD BEGINS	TOTAL NUM. DAYS	0.01	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
		AMOUNT EQUAL TO OR GREATER THAN											
JAN 1	300	190	100	60	20	3							
JAN 11	300	227	140	73	27	13	10	7	3	3			
JAN 21	330	185	115	67	21	6	3						
FEB 1	300	143	70	47	20	13	7	7	3				
FEB 11	300	170	93	47	17	7							
FEB 21	248	145	89	40	8	4							
MAR 1	300	183	123	63	17	10	7	3					
MAR 11	300	133	70	33	7	7	3						
MAR 21	330	145	100	45	9								
APR 1	300	143	107	57	17	13	13	7	7				
APR 11	300	143	60	37	23	7	3	3	3	3			
APR 21	300	210	150	110	47	33	10						
MAY 1	300	253	160	113	53	20	7	3	3	3			
MAY 11	300	253	190	130	90	50	27	17	10	3			
MAY 21	330	261	179	121	45	27	12	12	3	3	3		
JUN 1	300	307	227	153	103	67	27	13	10	3			
JUN 11	300	283	193	137	50	23	10	3	3	3			
JUN 21	300	230	160	97	53	37	23	13	7				
JUL 1	300	173	90	70	33	20	13	3	3				
JUL 11	300	150	73	53	30	10	3	3	3				
JUL 21	330	145	97	61	24	6	3	3	3				
AUG 1	300	170	110	67	37	20							
AUG 11	300	173	113	70	30	17	3	3	3				
AUG 21	330	145	100	55	27	12	6						
SEP 1	300	127	93	60	23	10	3	3					
SEP 11	300	223	147	100	57	43	37	17	13	10	7		
SEP 21	300	107	63	40	17	10	3	3	3	3			
OCT 1	300	107	77	50	20	10	10	3					
OCT 11	290	110	66	41	17	7	7	7	7				
OCT 21	324	123	86	43	12	9							
NOV 1	298	111	60	50	23	7	7						
NOV 11	297	155	101	34	10	7							
NOV 21	299	217	120	57	17								
DEC 1	296	179	108	57	27	3	3	3	3				
DEC 11	297	162	108	47	10	7							
DEC 21	324	179	105	65	34	15	15	15	9	6	3	3	
MONTH													
JAN	930	200	118	67	23	8	4	2	1	1			
FEB	848	153	84	45	15	8	2	2	1				
MAR	930	154	98	47	11	5	3	1					
APR	900	166	106	68	29	18	9	3	3	1			
MAY	930	256	176	122	62	32	15	11	5	3	1		
JUN	900	273	193	129	69	42	20	10	7	2			
JUL	930	156	87	61	29	12	6	3	3				
AUG	930	162	108	63	31	16	3	1	1				
SEP	900	152	101	67	32	21	14	8	6	4	2		
OCT	914	114	77	45	16	9	5	3	2				
NOV	894	161	94	47	17	4	2						
DEC	917	173	107	57	24	9	7	7	4	2	1	1	

(con.)

Table 17 (Con.)

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101932 COBALT 1962-1981

PERIOD BEGINS	TOTAL NUM. DAYS	0.01	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
		AMOUNT EQUAL TO OR GREATER THAN											
JAN 1	199	367	291	186	101	60	30	10	5				
JAN 11	199	342	286	206	90	55	35	30	20	10			
JAN 21	220	300	227	136	68	55	36	32	18				
FEB 1	200	195	160	120	45	25	10	5	5	5	5		
FEB 11	200	300	250	165	95	40	10	5					
FEB 21	165	261	218	164	61	12							
MAR 1	189	238	190	164	58	48	21	5					
MAR 11	190	311	232	168	63	32							
MAR 21	209	292	206	124	38	10	10						
APR 1	180	350	300	211	100	61	44	39	17	6			
APR 11	180	239	217	150	78	28	11	6	6	6			
APR 21	180	339	294	194	133	94	50	28	17	6	6	6	
MAY 1	170	335	265	212	129	65	24	24	12	6			
MAY 11	170	376	300	212	124	71	59	35	12				
MAY 21	187	332	257	182	128	70	53	32	27	5	5		
JUN 1	169	355	314	231	136	71	47	30	18	12	6		
JUN 11	170	406	347	271	153	112	76	47	35	12	6		
JUN 21	170	324	265	176	112	76	41	29	18	12	6		
JUL 1	170	241	206	165	71	47	35	29	18	12			
JUL 11	170	188	147	94	71	41	35	29	18	6			
JUL 21	187	176	139	123	59	53	37	27	21	5			
AUG 1	190	205	163	84	42	16	5	5	5				
AUG 11	190	221	195	153	95	68	47	32	5	5			
AUG 21	209	196	153	105	67	38	29	24					
SEP 1	190	174	142	126	84	47	32	21	11	5	5		
SEP 11	181	276	249	171	122	72	55	33	17	6	6		
SEP 21	189	180	148	111	58	11	5	5	5	5			
OCT 1	190	216	179	116	79	26	26	16	11	5			
OCT 11	190	211	174	142	79	37	16	5	5				
OCT 21	218	220	188	119	69	41	23	18	9				
NOV 1	190	316	258	184	89	32	11	11	5	5			
NOV 11	190	258	242	163	58	26	16	5	5				
NOV 21	188	330	255	170	90	53	32	27	16	5			
DEC 1	189	349	286	206	95	32	26	21	16	11	11		
DEC 11	190	279	226	163	74	42	21	11	5	5	5		
DEC 21	207	377	309	217	92	53	34	19	14	5	5		
MONTH													
JAN	618	335	267	175	86	57	34	24	15	3			
FEB	565	251	209	149	67	27	7	4	2	2	2		
MAR	588	281	209	151	53	29	10	2					
APR	540	309	270	185	104	61	35	24	13	6	2	2	
MAY	527	347	273	201	127	68	46	30	17	4	2		
JUN	509	361	308	226	134	86	55	35	24	12	6		
JUL	527	201	163	127	66	47	36	28	19	8			
AUG	589	207	170	114	68	41	27	20	3	2			
SEP	560	209	179	136	88	43	30	20	11	5	4		
OCT	598	216	181	125	75	35	22	13	8	2			
NOV	568	301	252	173	79	37	19	14	9	4			
DEC	586	336	275	196	87	43	27	17	12	7	7		

(con.)

Table 17 (Con.)

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 102575 DIXIE 1952-1980

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.01	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
JAN 1	280	543	471	339	218	139	68	46	29	18			
JAN 11	280	604	557	493	296	186	139	86	57	29	21		
JAN 21	308	523	461	380	263	166	101	81	58	19	13		
FEB 1	280	407	357	318	189	107	57	36	21	11	7		
FEB 11	280	532	475	386	225	125	75	46	11	4	4		
FEB 21	231	450	381	312	203	113	65	17					
MAR 1	280	486	439	346	196	104	79	50	29	7	7		
MAR 11	280	446	389	304	193	104	75	57	21	4			
MAR 21	308	435	390	325	192	114	62	32	19	3	3		
APR 1	280	421	379	314	161	82	61	43	14	4	4		
APR 11	280	414	343	271	175	107	68	43	29	7			
APR 21	280	396	329	271	154	61	39	21	11	7			
MAY 1	280	418	350	275	179	114	61	32	21	4			
MAY 11	280	375	318	264	161	89	61	46	29	4	4		
MAY 21	308	445	373	305	153	101	75	36	23	10	3		
JUN 1	280	407	354	293	204	139	93	64	32	18	7	4	
JUN 11	280	368	307	257	179	111	71	39	18	7	4		
JUN 21	280	332	282	243	157	111	75	50	29	14	7		
JUL 1	290	231	190	148	69	48	38	14	10	7	3		
JUL 11	290	145	110	86	52	34	24	21	7				
JUL 21	319	144	122	91	50	38	22	6	3	3	3		
AUG 1	280	200	139	100	61	39	25	18	4	4			
AUG 11	280	207	171	129	86	64	39	29	21	7	7		
AUG 21	308	234	179	130	91	55	42	39	26	10	3		
SEP 1	290	186	141	117	79	55	38	24	17	3	3		
SEP 11	290	310	259	203	152	117	69	38	24	10			
SEP 21	290	214	186	138	86	55	34	17	10	3	3		
OCT 1	290	224	197	169	110	93	62	34	28	17	14		
OCT 11	290	245	214	172	107	59	52	34	21	7	3		
OCT 21	319	339	282	241	154	88	69	47	31	19	9		
NOV 1	280	368	318	254	154	86	46	43	18	11	4		
NOV 11	280	475	386	282	182	111	61	32	18	7	4		
NOV 21	280	446	400	346	225	171	118	64	43	21	11		
DEC 1	290	500	459	393	234	148	100	72	41	31	10		
DEC 11	290	479	410	334	217	131	69	38	31	21			
DEC 21	319	539	483	367	229	160	103	69	41	19	9	3	
MONTH													
JAN	868	555	495	403	259	164	103	71	48	22	12		
FEB	791	464	406	340	206	115	66	34	11	5	4		
MAR	868	455	406	325	194	107	71	46	23	5	3		
APR	840	411	350	286	163	83	56	36	18	6	1		
MAY	868	414	348	282	164	101	66	38	24	6	2		
JUN	840	369	314	264	180	120	80	51	26	13	6	1	
JUL	899	172	140	108	57	40	28	13	7	3	2		
AUG	868	214	164	120	79	53	36	29	17	7	3		
SEP	870	237	195	153	106	76	47	26	17	6	2		
OCT	899	271	232	196	125	80	61	39	27	14	9		
NOV	840	430	368	294	187	123	75	46	26	13	6		
DEC	899	507	452	365	227	147	91	60	38	23	7	1	

(con.)

Table 17 (Con.)

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 105708 MC CALL 1951-1980

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.01	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
JAN 1	300	403	350	293	217	143	113	90	60	30	20		
JAN 11	300	527	497	423	297	223	163	97	67	37	20	7	
JAN 21	329	426	383	337	231	176	122	76	43	30	21	3	
FEB 1	300	350	320	260	183	123	80	50	37	13	3		
FEB 11	300	440	390	327	193	150	93	57	43	27	23		
FEB 21	248	367	327	254	173	113	77	52	28	16	8	4	
MAR 1	300	370	320	267	183	107	67	47	30	17	13	3	
MAR 11	300	360	290	257	190	123	63	30	23	3			
MAR 21	330	321	291	255	194	118	52	24	21	12	6		
APR 1	300	287	240	203	143	93	67	50	27	10	7		
APR 11	300	283	240	200	130	83	57	37	27	7			
APR 21	300	293	250	200	123	87	50	43	30	3			
MAY 1	300	330	283	223	140	87	70	37	23	3			
MAY 11	300	310	267	213	117	83	57	37	20				
MAY 21	330	315	261	206	139	103	58	21	18	6			
JUN 1	300	320	270	207	153	103	67	50	37	23	7	3	
JUN 11	300	297	230	180	123	73	50	30	23	7	3	3	
JUN 21	300	253	193	160	117	70	53	37	23	10	7		
JUL 1	300	153	110	73	23	20	17	7					
JUL 11	300	103	73	53	33	17	13	10	7	3	3		
JUL 21	330	97	73	48	24	18	6	3	3	3			
AUG 1	300	133	90	70	43	37	33	23	13	3	3		
AUG 11	300	170	137	103	77	53	40	27	17				
AUG 21	330	212	167	112	61	39	27	15	12	3			
SEP 1	300	117	93	83	63	30	27	20	13	10	7		
SEP 11	300	263	213	180	143	97	73	63	33	13	3		
SEP 21	300	180	133	113	60	43	27	23	10	3	3	3	
OCT 1	300	203	180	150	103	77	53	33	20	13	10	3	
OCT 11	300	220	193	170	120	100	57	47	23	13	10	3	
OCT 21	330	282	242	194	118	79	67	52	24	12	3		
NOV 1	300	327	283	243	170	113	67	33	17	13			
NOV 11	300	370	320	297	210	133	87	53	30	10	3		
NOV 21	299	391	358	318	227	174	124	64	40	7	3		
DEC 1	300	420	380	310	207	150	117	93	67	40	10		
DEC 11	299	381	331	288	191	130	90	67	43	30	7	3	
DEC 21	329	432	395	340	228	173	125	100	67	40	18	3	3
MONTH													
JAN	929	451	409	351	248	181	132	87	56	32	20	3	
FEB	848	387	347	282	184	130	84	53	37	19	12	1	
MAR	930	349	300	259	189	116	60	33	25	11	6	1	
APR	900	288	243	201	132	88	58	43	28	7	2		
MAY	930	318	270	214	132	91	61	31	20	3			
JUN	900	290	231	182	131	82	57	39	28	13	6	2	
JUL	930	117	85	58	27	18	12	6	3	2	1		
AUG	930	173	132	96	60	43	33	22	14	2	1		
SEP	900	187	147	126	89	57	42	36	19	9	4	1	
OCT	930	237	206	172	114	85	59	44	23	13	8	2	
NOV	899	363	320	286	202	140	92	50	29	10	2		
DEC	928	412	370	314	209	152	111	84	59	37	12	2	1

(con.)

Table 17 (Con.)

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 107706 RIGGINS 1951-1980

PERIOD BEGINS	TOTAL NUM. DAYS	0.01	0.05	0.10	AMOUNT EQUAL TO OR GREATER THAN 0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
JAN 1	280	282	221	157	86	50	36	21	11				
JAN 11	273	425	308	205	110	59	33	15	7				
JAN 21	308	286	198	120	52	32	23	19	19	6	3	3	
FEB 1	288	222	174	101	38	17	7	3	3				
FEB 11	289	370	284	173	73	55	24	14	7				
FEB 21	238	315	248	176	88	38	17	13	8	4	4		
MAR 1	289	308	232	138	83	31	24	7	7				
MAR 11	289	318	232	180	118	73	42	24	14	3	3		
MAR 21	319	339	263	204	103	66	25	6					
APR 1	280	364	296	221	139	82	54	21	7	7	4		
APR 11	280	346	261	182	118	79	29	18	7				
APR 21	280	311	268	189	100	54	32	25	14	4			
MAY 1	300	393	300	227	107	70	50	43	20	10	3		
MAY 11	300	343	260	200	107	70	40	33	17	10			
MAY 21	330	327	248	161	112	85	61	30	15	6	3		
JUN 1	300	347	257	203	147	100	70	53	27	13	7		
JUN 11	300	273	213	173	127	80	33	23	10	3	3		
JUN 21	300	253	207	163	80	40	33	23	17	13	7		
JUL 1	300	137	100	80	40	27	20	7	7	3	3	3	3
JUL 11	300	137	100	73	53	37	27	10	3				
JUL 21	330	106	85	67	36	18	6						
AUG 1	300	97	77	70	33	23	10	3	3	3	3		
AUG 11	300	153	127	83	37	27	17	13	10	7	3		
AUG 21	330	197	161	130	76	42	27	18	15	9	3		
SEP 1	299	130	97	77	30	23	20	7	7	3			
SEP 11	300	217	180	150	107	70	50	37	20	7			
SEP 21	300	183	137	93	53	37	23	13	7	7	3		
OCT 1	280	189	143	107	75	57	39	25	14	7	7		
OCT 11	280	211	171	143	96	54	36	25	18	7	7	4	
OCT 21	308	221	149	123	71	55	39	29	10				
NOV 1	279	272	186	125	65	29	22	18	11				
NOV 11	274	299	237	179	102	40	26	15	11	4			
NOV 21	280	271	211	154	96	46	25	14	14	7			
DEC 1	276	333	225	159	87	62	43	29	25	14	7		
DEC 11	270	278	222	152	85	48	22	7	7	4	4		
DEC 21	294	306	211	167	99	61	37	27	10	7	7	3	
MONTH													
JAN	861	329	240	159	81	46	30	19	13	2	1	1	
FEB	815	302	234	148	65	37	16	10	6	1	1		
MAR	897	322	243	175	101	57	30	12	7	1	1		
APR	840	340	275	198	119	71	38	21	10	4	1		
MAY	930	354	269	195	109	75	51	35	17	9	2		
JUN	900	291	226	180	118	73	46	33	18	10	6		
JUL	930	126	95	73	43	27	17	5	3	1	1	1	1
AUG	930	151	123	96	49	31	18	12	10	6	3		
SEP	899	177	138	107	63	43	31	19	11	6	1		
OCT	868	207	154	124	81	55	38	26	14	5	5	1	
NOV	833	281	211	152	88	38	24	16	12	4			
DEC	840	306	219	160	90	57	35	21	14	8	6	1	

(con.)

Table 17 (Con.)

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 108076 SALMON - SALMON 1 N 1951-1980

PERIOD BEGINS	TOTAL NUM. DAYS	0.01	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
						AMOUNT EQUAL TO OR GREATER THAN							
JAN 1	300	270	153	63	17	10	7						
JAN 11	300	343	170	80	40	23	10	3	3				
JAN 21	330	276	155	97	24	9	3	3					
FEB 1	300	217	127	70	27	13	10	7	3				
FEB 11	299	281	147	74	23	7							
FEB 21	248	234	129	60	4								
MAR 1	300	263	133	70	30	10							
MAR 11	300	210	117	57	23	3	3	3					
MAR 21	330	209	103	55	12	3							
APR 1	300	243	133	63	33	20	13	7	7	3			
APR 11	300	223	120	63	30	13	7	3					
APR 21	300	270	167	113	53	33	23	13	7	3	3	3	
MAY 1	300	327	203	143	57	33	17	10	7				
MAY 11	300	317	200	140	60	40	27	17	3				
MAY 21	330	318	236	176	94	58	21	9					
JUN 1	288	337	236	184	108	63	56	42	24	7	3		
JUN 11	293	386	242	177	85	48	27	17	10	3	3		
JUN 21	291	316	223	137	79	55	41	27	27	10			
JUL 1	299	231	154	87	43	27	13	3	3				
JUL 11	300	167	117	73	27	10	10	10	3				
JUL 21	330	170	112	76	36	18	12	9	6	3			
AUG 1	300	203	130	77	27	10	7	7	3				
AUG 11	300	217	150	103	53	23	7	3	3				
AUG 21	330	212	133	73	39	18	15	12	3				
SEP 1	300	150	107	57	23	13	7	7	3	3			
SEP 11	300	240	173	117	53	27	23	13	10	3	3		
SEP 21	300	170	87	37	10	7	7						
OCT 1	297	158	98	61	20	17	13	13	7				
OCT 11	300	173	110	70	37	10	3	3					
OCT 21	330	188	118	73	18	9	3	3					
NOV 1	300	223	160	93	23	13	10	10	10	7	3		
NOV 11	300	263	133	70	20	3	3						
NOV 21	300	250	153	97	27	13	7						
DEC 1	300	280	147	73	23	10	7	7	3				
DEC 11	300	253	153	87	27	23	13	7	3	3	3		
DEC 21	330	324	164	100	30	18	6	3	3	3			
MONTH													
JAN	930	296	159	81	27	14	6	2	1				
FEB	847	244	135	68	19	7	4	2	1				
MAR	930	227	117	60	22	5	1	1					
APR	900	246	140	80	39	22	14	8	4	2	1	1	
MAY	930	320	214	154	71	44	22	12	3				
JUN	872	346	234	166	91	55	41	29	21	7	2		
JUL	929	188	127	79	36	18	12	8	4	1			
AUG	930	211	138	84	40	17	10	8	3				
SEP	900	187	122	70	29	16	12	7	4	2	1		
OCT	927	174	109	68	25	12	6	6	2				
NOV	900	246	149	87	23	10	7	3	3	2	1		
DEC	930	287	155	87	27	17	9	5	3	2	1		

(con.)

Table 17 (Con.)

PRECIPITATION - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 109560 WARREN 1960-1981

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.01	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.80	1.00	1.50	2.00
JAN 1	220	359	350	323	223	155	100	68	59	32	14		
JAN 11	220	386	368	295	218	145	109	73	45	23	18	9	5
JAN 21	242	322	318	277	190	136	95	79	41	8	8	8	
FEB 1	220	300	286	236	168	68	55	32	32	23	14		
FEB 11	220	327	318	250	182	136	77	45	27	14	5	5	
FEB 21	182	258	253	231	143	99	49	33	16				
MAR 1	220	286	282	250	191	114	55	32	27	14	14	5	
MAR 11	220	300	295	268	186	136	91	68	59	14	9		
MAR 21	242	306	302	273	194	99	70	41	21	8	4		
APR 1	220	364	350	300	168	91	55	18	5				
APR 11	220	305	286	250	159	77	50	45	27	9	5		
APR 21	220	277	255	205	150	100	45	36	23	14	5		
MAY 1	220	368	332	277	164	105	64	36	23	9			
MAY 11	220	355	332	259	159	91	50	27	14				
MAY 21	242	355	318	240	153	120	79	62	37	21	12		
JUN 1	220	345	318	264	173	118	73	59	45	9	9	5	5
JUN 11	220	350	327	273	182	109	77	41	32	9	9		
JUN 21	220	268	236	214	141	95	64	32	27	14	14		
JUL 1	220	182	141	118	64	45	36	23	23	18			
JUL 11	219	128	110	78	55	37	23	18	14	9			
JUL 21	242	136	103	79	54	33	21	21	17	4	4		
AUG 1	220	145	118	86	59	32	18	5	5	5	5		
AUG 11	220	227	205	182	114	77	50	41	32	9	5		
AUG 21	242	231	186	149	66	41	21	12	8				
SEP 1	220	136	118	105	64	45	36	32	27	18	9		
SEP 11	220	300	282	223	182	36	77	55	23	5			
SEP 21	220	214	182	155	82	41	32	23	23	18			
OCT 1	219	247	224	183	132	82	68	41	37	18	9		
OCT 11	219	219	205	169	119	91	73	46	27	23	14	5	5
OCT 21	242	256	231	215	140	83	62	45	17	12			
NOV 1	220	268	250	209	118	73	59	41	18	14	9	5	5
NOV 11	220	341	323	277	173	123	82	64	36	23			
NOV 21	220	414	405	350	209	150	82	55	45	9			
DEC 1	220	359	327	291	182	105	86	68	41	27	23		
DEC 11	220	323	323	277	191	95	55	41	23	18	9	5	
DEC 21	242	384	380	318	211	149	91	62	50	29	12	4	
MONTH													
JAN	682	355	345	298	210	145	101	73	48	21	13	6	1
FEB	622	297	288	240	166	101	61	37	26	13	6	2	
MAR	682	298	293	264	191	116	72	47	35	12	9	1	
APR	660	315	297	252	159	89	50	33	18	8	3		
MAY	682	359	327	258	158	106	65	43	25	10	4		
JUN	660	321	294	250	165	108	71	44	35	11	11	2	2
JUL	681	148	117	91	57	38	26	21	18	10	1		
AUG	682	202	170	139	79	50	29	19	15	4	3		
SEP	660	217	194	161	109	74	48	36	24	14	3		
OCT	680	241	221	190	131	85	68	44	26	18	7	1	1
NOV	660	341	326	279	167	115	74	53	33	15	3	2	2
DEC	682	356	345	296	195	117	78	57	38	25	15	3	

Table 18—Monthly and annual (seasonal) snowfall, inches, by individual years; at stations adjacent to western edge of RNR. T denotes trace, amount too small to measure. M denotes amount missing, no estimate made; E, amount partially or wholly estimated

McCall, ID

Season	Snowfall										
	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Annual
	Inches										
1930-31	0.0	0.0	10.0	14.0	19.1	22.0	31.0	0.0	0.0	0.0	96.1
31-32	3.0	T	29.0	45.0	23.0	13.0	13.0	T	.0	.0	126.0
32-33	.0	3.0	3.0	26.5	47.0	27.0	11.0	1.0E	.0	.0	118.5
33-34	T	T	4.0	36.5	11.0	4.0	2.0	T	.0	.0	57.5
34-35	1.0	4.0	13.2	22.0	31.0	13.0	23.6	16.0	.0	.0	123.8
35-36	.0	2.5	13.5	15.5	63.5	45.3	15.3	9.0	3.0	.0	167.6
36-37	.0	0.0	T	22.0E	54.0E	48.0E	10.0E	14.0E	.0	.0	148.0
37-38	.0	0.0	20.0E	29.0	16.3	45.0	42.5	5.0	2.5	.0	160.3
38-39	.0	T	20.5	19.5	31.0	35.0	30.0	1.0	.0	.0	137.0
39-40	.0	4.0	.0	5.0	26.0	37.0	8.0	5.0	.0	.0	85.0
1940-41	.0	.0	20.0	17.0	33.0	23.0	5.0	.0	4.0	.0	102.0
41-42	.0	.0	.0	36.0	10.0	32.0	6.0	2.0	2.0	.0	88.0
42-43	.0	4.0	17.0	46.0	45.0	12.0	8.0	.0	T	.0	132.0
43-44	.0	3.2	2.0	20.0	13.2	21.0	17.2	5.0	.0	.0	81.6
44-45	.0	.0	8.0	17.4	13.7	27.7	14.0	2.0	.0	.0	82.8
45-46	.0	.0	40.0E	33.0E	24.5	32.5	12.0E	5.0E	.0	.0	147.0
46-47	.0	1.0	34.0E	6.5	22.0	5.0	12.0	.0	.0	.0	80.5
47-48	.0	.0	16.0E	23.0	16.0E	22.0	27.0	15.0	2.0	.0	121.0
48-49	.0	.0	23.0	47.2	16.9	50.0E	2.5E	.0	.0	.0	139.6
49-50	.0	.0	8.0E	53.8	63.0	6.6	24.0	.0	.0	.0	155.4
1950-51	.0	.0	8.0E	43.0E	38.0E	24.0	42.0E	.0	.0	.0	155.0
51-52	.0	.0	15.0	87.0E	77.0	54.5	35.0	3.0	.0	.0	271.5
52-53	.0	.0	9.0	50.0	51.0	28.0	29.0	17.0E	1.0E	.0	185.0
53-54	.0	.0E	11.0	31.0	89.0	22.0E	15.0	.0	.0	.0	168.0
54-55	.0	.0	1.0E	34.5E	43.0	31.0	27.0	39.0E	.0	.0	175.5
55-56	.0	.0	30.0E	45.0	57.0	54.0	28.0	M	.0	.0	214.0+
56-57	.0	25.0	6.0	39.0	52.0	M	M	2.0	.0	.0	M
57-58	.0	3.0E	8.0	44.0	52.0	28.0	15.0E	22.0	.0	.0	172.0
58-59	2.0	.0	5.0	14.0	36.5E	41.0	29.0	2.5E	.0	.0	130.0
59-60	.0	.0	7.0E	12.0	35.0	43.0	34.0	.0	5.0	.0	136.0
1960-61	.0	T	46.0	10.0	20.0	21.0	36.0	5.0	5.0	.0	143.0
61-62	.0	6.0	27.0	44.0	32.0	32.0	44.0	1.0	.0	.0	186.0
62-63	.0	.0	19.0	2.0	34.2	5.0	19.0	T	.0	.0	79.2
63-64	.0	.0	21.0	25.0E	65.5	7.5	59.0	15.0	5.0	.0	198.0
64-65	.0	.0	20.0	66.0E	84.5	18.0	5.0	17.0	T	.0	210.5
65-66	.0	.0	7.5E	20.0E	50.5	30.0	37.0	1.0	3.0	.0	149.0
66-67	.0	7.0E	18.3	44.5	69.0	23.0	46.0	27.0	T	.0	234.8
67-68	.0	T	14.0	41.5E	55.0	10.0	25.0	12.0	T	.0	157.5
68-69	T	1.0E	28.5	63.0	79.0	40.0	13.0	4.0	.0	.0	228.5
69-70	.0	3.0E	3.0E	28.0E	60.0	18.0	14.0	12.0	4.0	.0	142.0
1970-71	.0	14.5	30.0	90.0	74.5	33.0	27.0	3.0	.0	.0	272.0
71-72	T	3.0	28.5	60.0	38.0	20.0	7.0	10.5	.0	.0	167.0
72-73	.0	.0	9.5	17.0	27.0	10.0	14.0	1.5E	.0	.0	79.0
73-74	.0	.0	70.0	47.0	35.0	44.0	34.0	8.0	.0	.0	238.0
74-75	.0	.0	12.5	51.0	33.0	70.0	49.0	19.0E	3.0	.0	237.5
75-76	.0	11.0	36.0	15.0	50.0	35.0	24.0	5.0	.0	.0	176.0
76-77	.0	.0	T	10.5	12.0	9.0	24.0	3.0	.5E	.0	59.0
77-78	.0	1.0	11.0	38.0	45.0	31.0	4.0	10.0E	2.0E	.0	142.0
78-79	1.0E	.0	17.5	29.0	24.0	48.0	5.0	6.0	2.0	.0	132.5
79-80	.0	1.0E	15.0	27.0	21.0	18.0	24.0	5.0	2.0	.0	113.0
1980-81	.0	1.0	8.0	28.0	18.0	10.0	5.0	9.0	.0	.0	79.0
81-82	.0	1.0E	14.0	28.0	50.0	17.5	30.0	12.0	T	.0	152.5
82-83	.0	4.0	22.0	43.0	21.0	40.0	15.0	5.0	3.0	.0	153.0
83-84	.0	.0	19.0	57.0	19.0	37.0	17.0	11.0	3.0E	.0	163.0
84-85	.0	6.0	29.0E	40.5	5.0	30.5	25.0	4.0	2.0	.0	142.0
85-86	.0	4.0	25.0E	12.5	26.0	35.0	5.0E	5.0	.5	.0	113.0
86-87	.0	.0	23.0	5.5	34.0	13.0	10.5	4.5	.0	.0	90.5
10-year averages											
1931-40	0.4	1.4	11.3	23.0	32.2	28.9	18.6	5.1	0.6	0.0	122.0
41-50	.0	.8	16.8	30.0	25.7	23.2	11.8	2.9	.8	.0	113.0
51-60	.2	2.8	10.0	40.0	53.1	[1]36.2	[1]28.2	[1]9.5	.6	.0	180.5
61-70	T	1.7	20.4	34.4	55.0	20.5	29.8	9.4	1.7	.0	172.9
71-80	.1	3.1	23.0	38.5	36.0	31.8	21.2	7.1	1.0	.0	161.6
30-year averages											
1931-60	.2	1.7	12.7	31.0	37.0	[2]29.2	[2]19.2	[2]5.72	.7	.0	137.4
41-70	.1	1.8	15.7	34.8	44.6	[2]26.3	[2]23.1	[2]7.2	1.0	.0	154.6
51-80	.1	2.5	17.8	37.6	48.0	[2]29.2	[2]26.3	[2]8.6	1.1	.0	171.2

(con.)

Table 18 (Con.)

Deadwood Dam, ID[3]

Season	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Annual
	Snowfall										
	Inches										
1930-31	T	T	18.0	M	27.4	M	M	0.0	T	0.0	M
31-32	T	5.0	39.0	101.0	54.0	33.5	38.5	11.0E	T E	.0	282.0
32-33	T	1.5	13.0	57.0	97.0	63.0	10.5	8.0	4.0	.0	254.0
33-34	1.0	T	3.0	78.0	7.0	5.0	3.0E	3.0	.0	.0	100.0
34-35	T	9.0	28.5	42.5	39.5	11.0	27.0	21.0	.0	.0	178.5
35-36	.0	12.0	14.5	29.0	65.0	83.0	27.0	9.0E	.5	.0	240.0
36-37	T	.8	2.0	30.0	51.0	53.0	26.0	11.0	T	T	173.8
37-38	.0	.0	26.0E	38.6	42.0	56.0	68.0	7.0E	3.0	.0	240.6
38-39	.0	1.0	24.0E	24.0	36.0	33.0	33.0	T	T	T	151.0
39-40	.0	4.0	.5	9.5E	40.0	67.0	23.0E	1.0	T	T	145.0
1940-41	.0	1.0	30.0	37.0	43.0	26.0	3.0	8.0	T	.0	148.0
41-42	.0	1.0	1.0	50.0	29.0	31.0	8.0	7.0E	2.0	T	129.0
42-43	T	2.0	43.0E	78.0	55.0	25.0	27.0	5.0	T	T	235.0
43-44[4]	.0	13.0	9.0	16.0	15.0	28.0	27.0	15.0	.5	T	123.5
44-45	T	T	17.0	25.0	15.0	26.0	23.0	7.0	T	T	113.0
45-46	T	2.0	50.0	44.0	41.0	37.0	22.0	7.0	T	T	203.0
46-47	T	T	47.0	13.2	36.0	14.5	20.0	1.0	.0	.0	131.7
47-48	.0	T	19.0	19.0	26.5	30.5	29.5	19.5	2.0	.0	146.0
48-49	.0	T	31.5	81.0	20.0	96.5	3.0	T	T	T	232.0
49-50	.0	1.0	4.5	54.0	111.0	28.5	46.0	1.4	.5	T	246.9
1950-51	T	1.0	14.0	36.0	56.5	27.5	48.0	1.0	T	T	184.0
51-52	.0	3.0	20.5	90.5	75.5	32.0	19.5	1.0	1.0	T	243.0
52-53	.0	T	12.0	81.5	60.0	27.0	21.5	10.5	4.5	.0	217.0
53-54	.0	.0	13.3	36.5	85.5	15.0	14.5	T	3.0	T	167.8
54-55	T	.0	1.0	35.5	25.0	35.0	35.5	22.5	2.0	T	156.5
55-56	.0	1.0	59.7	60.9	64.5	55.5	15.6	4.3	T	.0	261.5
56-57	.0	52.0	12.4	26.4	54.9	48.1	43.4	6.0	.0	.5	243.7
57-58	.0	5.1	14.5	86.8	52.5	32.5	36.7	36.1	T	.0	264.2
58-59	T	T	21.0	24.1	62.7	58.1	33.1	2.9	.9	.0	202.8
59-60	T	1.0	5.5	18.8	44.7	52.5	32.1	7.5	6.7	.0	168.8
1960-61	.0	2.2	46.2	18.2	11.1	27.7	34.4	3.3	10.1	.0	153.2
61-62	.2	13.7	48.8	52.4	26.6	33.4	44.9	5.2	T	.5	225.7
62-63	.0	4.5	16.5	6.1	20.6	8.1	25.1	23.2	1.5	T	105.6
63-64	.0	.0	1.0	26.2	27.0	81.0	7.7	59.4	15.1	2.0	219.4
64-65	.0	.0	32.2	91.0	78.7	11.2	14.7	20.0	1.5	.0	249.3
65-66	T	T	22.3	48.5	60.3	25.0	29.0	2.5	T	T	187.6
66-67	.0	3.5	18.5	43.1	55.0	9.6	28.5	15.8	6.0	.0	180.0
67-68	.0	T	11.0	38.0	52.0	15.0	11.5	1.0	T	T	128.5
68-69	T	T	31.3	80.5	97.0	45.0	12.0	T	T	.0	265.8
69-70	.0	T	1.0	37.0	37.0	3.0	18.0	10.5	8.0	.0	114.5
1970-71	.0	14.0	38.0	64.0	38.0	24.0	26.0	4.5	T	T	208.5
71-72	1.5	6.0	38.0	61.0	41.0	28.5	11.5	17.0	T	.0	204.5
72-73	T	1.0	4.0	30.5	46.0	24.5	6.5	1.0	.0	T	113.5
73-74	.0	.5	60.0E	50.0	46.0	30.0	27.0	9.0	1.0	T	223.5
10-year averages											
1931-40	.1	3.3	16.9	[1]45.5	45.9	[1]44.9	[1]28.4	7.1	.8	T	192.9
41-50	T	2.0	25.2	41.7	39.2	34.3	20.9	7.1	.5	T	170.8
51-60	T	6.3	17.4	49.7	58.2	38.3	30.0	9.2	1.8	.1	210.9
61-70	T	2.4	22.9	44.1	46.5	25.9	22.6	14.1	4.2	.3	183.0

(con.)

Table 18 (Con.)

Dixie, ID[5]

Season	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Annual
	Snowfall										
	Inches										
1952-53	0.0	2.4	4.6	35.3	95.3	54.1	37.9	27.6	3.7	T	260.9
53-54	T	1.6	26.2	69.0	75.4	24.0	M	M	T	T	M
59-60	T	4.0	25.0	14.0	23.2	36.0	43.1	20.0	15.5	.0	180.8
1960-61[4]	.0	12.5	59.5	34.5	12.5	40.5	31.5	28.0	19.0	.0	238.0
61-62	7.0	27.0	56.5	63.0	32.5	19.5	36.0	3.5	T	.5	245.5
62-63	T	7.0	18.0	14.0	41.2	10.5	39.6	24.5	4.0	.0	158.8
63-64	.0	1.0	M	M	M	M	M	8.0	4.0	T	M
67-68	T	3.0	28.0	52.5	44.0	22.0	24.0	22.5	6.5	T	202.5
68-69	6.0	16.0E	29.5	58.5	64.5	19.3	15.5	10.0	2.5	.0	221.8
69-70	.0	16.5E	7.5	29.0	70.5	23.5	41.5	34.0	1.5	1.0	225.0
1970-71	.5	11.5	33.0	47.5	90.5	38.0	34.5	19.0	5.0	.0	279.5
71-72[4]	2.0	7.5	47.5	70.0	86.0	64.0	35.5	29.0	2.0	.0	343.6
72-73	3.0	2.0	24.0	38.0	21.0	10.5	25.0	14.0	2.5	2.0	142.0
73-74	.0	5.5	63.5	60.0	52.5	52.0	53.5	17.0	10.0	3.5	317.5
74-75	.0	3.5	17.0	60.5	85.5	49.5	21.5	34.5	19.0	.0	291.0
75-76	.0	28.5	44.5	45.5	55.0	41.0	30.5	22.0	3.0	1.5	271.5
76-77	.0	1.5	3.3	19.0	20.5	16.5	66.5	11.0	15.0	.0	153.3
77-78	2.0	10.0	44.5	66.5	31.5	39.5	14.0	19.5	12.5	.5	240.5
78-79	1.0	1.0	17.0	71.5	29.5	54.5	13.0	24.5	7.5	1.0	220.5
79-80	.0	6.5	23.5	21.5	34.0	19.5	35.5	9.5	12.0	6.0	168.0
1980-81	1.0E	3.0	12.0E	34.1	6.0	17.8	15.0	14.8	2.0	.0	104.7
81-82	.0	7.5E	22.0E	63.6	79.2	32.8	31.6	40.0E	7.5	.0	284.2
82-83	.0	17.0	20.6	46.9	29.3	24.4	25.8	13.0	14.0	1.5	192.5
83-84	.0	1.0E	32.5	46.5	28.5	31.5	46.1	17.8	11.5	.0	215.4
84-85	4.0	17.7	28.6	53.3	10.0	14.0	M	M	1.0	.0	M
85-86	T E	10.0E	34.7	8.5	26.1	46.9	22.5	16.9	12.0	.0	177.6
86-87	2.2	M	36.3	6.0	18.0	17.8	17.0	10.0E	1.0	.0	108.3

(con.)

Table 18 (Con.)

Warren, ID

Season	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Annual
						Snowfall					
						Inches					
1959-60	T E	2.5	16.2	16.7	19.5	28.9	22.9	14.4	15.1	0.0	136.2
1960-61[4]	.0	3.0	41.3	16.0	7.1	17.1	28.0	12.5	20.0	.0	145.0
61-62	2.0	16.0	35.0	30.5	23.5	14.0	16.0	7.5	1.0	2.0	147.5
62-63	.0	3.7	16.2	15.5	25.3	7.0	28.0	15.5	9.0	1.0	121.2
63-64	.0	2.5	15.5	26.5	63.5	17.3	39.0	13.0	17.0	.0	194.3
64-65	.0	.0	18.0	74.5	94.2	29.0	9.5	7.3	8.0	.0	240.5
65-66	2.0	6.0	14.0	39.2	51.5	24.0	26.5	8.0	4.5	.0	175.7
66-67	T	18.0	29.0	41.5	67.5	25.0	63.0	45.5	T	T	289.5
67-68	1.0	2.0	12.0	59.0	45.0	11.0	24.0	33.0	10.0	T	197.0
68-69	7.0	6.0	36.0	39.0	57.0	24.5	12.5	10.0	T	T	192.0
69-70	.0	16.5	7.0	26.0	47.0	18.5	41.0	15.0	2.0	8.0	181.0
1970-71	1.0	29.0	30.0	70.5	67.0	34.0	45.5	27.0	2.0	.0	306.0
71-72	3.0	7.4	23.5	51.5	48.0	39.0	22.0	22.5	3.5	.0	220.4
72-73	.0	3.0	20.5	16.5	18.5	10.0	32.5	13.0	.0	5.0	119.0
73-74	.0	7.0	57.0	40.0	39.0	42.7	52.5	17.5	2.0	2.0	259.7
74-75[4]	.0	5.0	16.5	53.5	73.2	55.5	25.5	26.0	13.5	T	268.7
75-76	.0	15.0E	45.0	27.5	36.5	33.5	32.0	24.0	.0	3.0	216.5
76-77[4]	.0	1.0	4.5	10.0	18.5	15.0	59.0	5.0	9.5	.0	122.5
77-78	1.5	5.5	23.0	51.0	31.5	25.5	12.0	24.5	7.5	.0	182.0
78-79	2.0	1.5	14.5	48.5	13.5	45.0	7.0	13.0	6.0	T	151.0
79-80	.0	3.0E	9.0	11.5	31.0	13.8	56.5	13.2	9.5	.0	147.5
1980-81	.0	10.5	5.0E	22.5	10.0	12.0	15.7	11.4	5.9	.0	93.0
81-82	1.5	12.0	34.0	25.5	59.0	24.0	32.5	33.0	6.2	.0	227.7
82-83	.0	5.0	25.2	46.0	18.5	15.7	34.7	5.5	9.9	.0	160.5
83-84	.0	.0	27.0E	37.0	25.5	29.0	M	17.5	14.5		M
84-85	T	16.1	29.6	43.3	7.5	29.0	27.5	6.0E	6.5E	.0	165.5
85-86	.3	7.8	19.6	11.0	27.8	40.0E	9.0	8.0	.5	.0	124.0
86-87	.5	M	25.5	3.0	13.0	9.5	13.0	6.0	.0	.0	70.5+
10-year averages											
1961-70	1.2	7.4	22.4	36.8	48.2	18.7	28.8	16.7	7.2	1.1	188.4
71-80	0.8	7.7	24.4	38.1	37.7	31.4	34.5	18.6	5.4	1.0	199.3

[1]Average for 9 years.
[2]Average for 29 years.
[3]Station known as Deadwood, at nearby site, prior to May 1940; snowfall amounts apparently not compatible (relatively high at former location).
[4]Trace snowfall in August.
[5]Snowfall not measured during 1954-59 and 1964-67.

Table 19—Observed frequencies of daily snowfall amounts, inches, for indicated periods of record

SNOWFALL - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 100835 BIG CREEK 1 S 1949-1967

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.5	1	2	4	6	8	10	12	16	20	24
JAN 1	160	413	375	263	113	56	6	6	6			
JAN 11	160	438	425	306	150	100	44	25	25	6		
JAN 21	176	438	432	216	97	74	28	23	11	6		
FEB 1	178	303	287	180	90	45	22	17	17			
FEB 11	170	406	388	224	88	47	18	12	12	6		
FEB 21	145	283	248	166	41	7						
MAR 1	170	353	347	224	112	47	24	12				
MAR 11	170	341	312	194	94	35						
MAR 21	187	305	294	198	80	37	11	5				
APR 1	180	200	183	89	17	6	6	6	6			
APR 11	180	211	211	139	50	17	11	6	6			
APR 21	180	128	128	89	17	11						
MAY 1	180	117	111	72	11							
MAY 11	180	56	50	28	6	6						
MAY 21	198	40	35	20	5							
JUN 1	180	11	11	11								
JUN 11	180	6	6									
JUN 21	180	17	17	11								
JUL 1	180	6	6									
JUL 11	180											
JUL 21	198											
AUG 1	190											
AUG 11	190											
AUG 21	208											
SEP 1	170											
SEP 11	170											
SEP 21	170	18	18	12								
OCT 1	160	56	31	6								
OCT 11	160	50	50	31	13							
OCT 21	176	136	119	68	34	11						
NOV 1	170	100	94	53	12	12						
NOV 11	170	259	241	165	47	24	12	6				
NOV 21	170	329	300	194	71	35						
DEC 1	170	459	435	259	94	47	24	18	12			
DEC 11	163	356	319	245	98	61	25	12	6	6		
DEC 21	176	403	375	267	119	63	34	23	6			
MONTH												
JAN	496	429	411	260	119	77	26	18	14	4		
FEB	493	333	310	191	75	34	14	10	10	2		
MAR	527	332	317	205	95	40	11	6				
APR	540	180	174	106	28	11	6	4	4			
MAY	558	70	65	39	7	2						
JUN	540	11	11	7								
JUL	558	2	2									
AUG	588											
SEP	510	6	6	4								
OCT	496	83	69	36	16	4						
NOV	510	229	212	137	43	24	4	2				
DEC	509	407	377	257	104	57	28	18	8	2		

(con.)

Table 19 (Con.)

SNOWFALL - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101932 COBALT 1962-1981

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.5	1	2	4	6	8	10	12	16	20	24
JAN 1	159	346	277	182	69	38	25	6				
JAN 11	160	288	250	119	31	13						
JAN 21	176	273	199	108	17	11	6					
FEB 1	180	178	133	78	17							
FEB 11	180	217	172	106	28							
FEB 21	148	142	115	101	20							
MAR 1	170	194	147	106	35							
MAR 11	170	206	176	76	35	6						
MAR 21	187	155	128	59	16	5						
APR 1	160	169	144	75	38	13						
APR 11	160	75	38	19	13							
APR 21	160	106	88	44	38	19	6	6	6	6		
MAY 1	180	44	33	22								
MAY 11	174	11	6									
MAY 21	198	15	10	10								
JUN 1	180											
JUN 11	180	6	6									
JUN 21	180											
JUL 1	180											
JUL 11	180											
JUL 21	198											
AUG 1	180											
AUG 11	180											
AUG 21	198											
SEP 1	190											
SEP 11	190	21	11	11	5							
SEP 21	190	11	11									
OCT 1	190	16	11									
OCT 11	190	21	16	5								
OCT 21	209	77	57	33								
NOV 1	171	117	82	41	6	6						
NOV 11	169	136	95	30	6							
NOV 21	170	288	224	129	29							
DEC 1	149	302	235	134	27	20						
DEC 11	150	240	160	93	27							
DEC 21	165	297	230	127	42	18						
MONTH												
JAN	495	301	240	135	38	20	10	2				
FEB	508	181	142	94	22							
MAR	527	184	150	80	28	4						
APR	480	117	90	46	29	10	2	2	2	2		
MAY	552	24	16	11								
JUN	540	2	2									
JUL	558											
AUG	558											
SEP	570	11	7	4	2							
OCT	589	39	29	14								
NOV	510	180	133	67	14	2						
DEC	464	280	209	119	32	13						

Table 19 (Con.)

SNOWFALL - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 102575 DIXIE 1962-1981

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.5	1	2	4	6	8	10	12	16	20	24
JAN 1	159	535	440	277	145	57	19	19				
JAN 11	160	581	525	381	181	81	38	25	13			
JAN 21	176	438	369	250	142	74	40	6	6			
FEB 1	160	350	331	238	119	38	25	19	6			
FEB 11	160	475	375	256	100	56	6	6				
FEB 21	132	447	364	205	98	15						
MAR 1	160	400	319	200	100	63	31	13	13			
MAR 11	160	406	338	163	69	25	13	13	6			
MAR 21	176	420	364	222	80	34	6					
APR 1	180	339	300	172	56	11						
APR 11	180	261	206	144	28							
APR 21	180	250	200	133	61	11	6					
MAY 1	180	144	106	61	22	11						
MAY 11	180	89	72	39	6							
MAY 21	198	71	56	40	20	5						
JUN 1	180	33	28	17								
JUN 11	180	17	17									
JUN 21	180	6	6									
JUL 1	180											
JUL 11	180											
JUL 21	198											
AUG 1	180											
AUG 11	180											
AUG 21	198											
SEP 1	190											
SEP 11	190	5	5									
SEP 21	190	53	47	16	5							
OCT 1	190	42	32	26	11							
OCT 11	190	53	42	37	16							
OCT 21	209	191	167	91	33	14	5					
NOV 1	171	251	205	88	35	6	6					
NOV 11	160	363	269	144	63	19						
NOV 21	160	456	425	306	188	69	25	19	6			
DEC 1	160	513	450	319	156	81	44	19				
DEC 11	160	506	438	281	119	25	13	13				
DEC 21	176	585	511	364	170	51	28	11				
MONTH												
JAN	495	515	442	301	156	71	32	16	6			
FEB	452	423	356	235	106	38	11	9	2			
MAR	496	409	341	196	83	40	16	8	6			
APR	540	283	235	150	48	7	2					
MAY	558	100	77	47	16	5						
JUN	540	19	17	6								
JUL	558											
AUG	558											
SEP	570	19	18	5	2							
OCT	589	98	83	53	20	5	2					
NOV	491	354	297	177	94	31	10	6	2			
DEC	496	536	468	323	149	52	28	14				

(con.)

Table 19 (Con.)

SNOWFALL - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 105708 MC CALL 1951-1980

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.5	1	2	4	6	8	10	12	16	20	24
JAN 1	292	387	384	301	175	89	45	34	14	7		
JAN 11	289	412	408	349	180	87	48	14	10	3	3	
JAN 21	319	386	386	310	154	78	34	13	6	6	3	
FEB 1	290	307	307	255	124	55	10	3	3			
FEB 11	290	341	338	286	117	41	17	10	3			
FEB 21	231	268	268	190	95	39	9	4				
MAR 1	280	275	275	236	111	43	25	11	7			
MAR 11	280	268	268	214	93	36	14	7	4			
MAR 21	308	205	205	166	68	29	10	3	3	3	3	
APR 1	289	149	149	100	31	3						
APR 11	288	101	87	59	38	10	3	3				
APR 21	290	79	72	59	21	10						
MAY 1	290	34	31	17	3							
MAY 11	290	10	10	7								
MAY 21	319	9	9	3	3							
JUN 1	289											
JUN 11	289											
JUN 21	290											
JUL 1	290											
JUL 11	290											
JUL 21	318											
AUG 1	300											
AUG 11	300											
AUG 21	329											
SEP 1	300											
SEP 11	300	3	3									
SEP 21	300	7	7	7	3							
OCT 1	300	10	10	3								
OCT 11	300	10	10	3								
OCT 21	329	67	67	40	24	9	3	3	3			
NOV 1	300	60	60	40	27	20	7	3	3			
NOV 11	300	197	193	130	73	30	3					
NOV 21	300	263	260	200	117	60	10	3				
DEC 1	280	318	314	250	118	64	32	14	11	4	4	
DEC 11	279	297	290	233	108	50	22	14	7			
DEC 21	305	361	351	295	167	89	33	23	7			
MONTH												
JAN	900	394	392	320	169	84	42	20	10	6	2	
FEB	811	308	307	248	113	46	12	6	2			
MAR	868	248	248	204	90	36	16	7	5	1	1	
APR	867	110	103	73	30	8	1	1				
MAY	899	18	17	9	2							
JUN	868											
JUL	898											
AUG	929											
SEP	900	3	3	2	1							
OCT	929	30	30	16	9	3	1	1	1			
NOV	900	173	171	123	72	37	7	2	1			
DEC	864	326	319	260	132	68	29	17	8	1	1	

(con.)

Table 19 (Con.)

SNOWFALL - PERCENT FREQUENCY OF DAILY AMOUNTS (INCHES)

- GIVEN TO NEAREST TENTH PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 108395 SHOUP 1966-1981

PERIOD BEGINS	TOTAL NUM. DAYS	AMOUNT EQUAL TO OR GREATER THAN 0.5	1	2	4	6	8	10	12	16	20	24
JAN 1	150	287	220	120	47	20						
JAN 11	150	247	207	113	20	7	7					
JAN 21	164	159	128	67	6							
FEB 1	150	140	120	60	13							
FEB 11	150	120	120	87	7							
FEB 21	124	65	32	16								
MAR 1	140	57	57	14	14	14						
MAR 11	140	14	14									
MAR 21	154											
APR 1	139											
APR 11	140											
APR 21	140	7	7	7								
MAY 1	150											
MAY 11	150											
MAY 21	165											
JUN 1	150											
JUN 11	150											
JUN 21	150											
JUL 1	150											
JUL 11	150											
JUL 21	165											
AUG 1	150											
AUG 11	150											
AUG 21	165											
SEP 1	150											
SEP 11	150											
SEP 21	150											
OCT 1	150											
OCT 11	150											
OCT 21	162	6	6									
NOV 1	150	27	13									
NOV 11	150	20	20	7								
NOV 21	150	233	180	73	33	7	7					
DEC 1	139	245	194	101	50	43						
DEC 11	140	271	221	86	29	7						
DEC 21	154	279	247	162	45	13						
MONTH												
JAN	464	228	183	99	24	9	2					
FEB	424	111	94	57	7							
MAR	434	23	23	5	5	5						
APR	419	2	2	2								
MAY	465											
JUN	450											
JUL	465											
AUG	465											
SEP	450											
OCT	462	2	2									
NOV	450	93	71	27	11	2	2					
DEC	433	266	222	118	42	21						

(con.)

Table 19 (Con.)

STATION NUMBER 109560 WARREN 1960-1981

PERIOD BEGINS	TOTAL NUM. DAYS	0.5	1	2	4	6	8	10	12	16	20	24
JAN 1	220	409	373	273	182	64	32	18	14	5		
JAN 11	220	409	377	250	123	55	27	18	5			
JAN 21	242	355	326	223	124	74	41	17	8	4		
FEB 1	220	282	264	195	77	27	9	5	5	5		
FEB 11	220	332	318	200	95	23	14	14	14			
FEB 21	182	308	280	159	77	33						
MAR 1	220	327	305	209	105	36	9	5	5	5	5	
MAR 11	220	314	291	232	100	50	27	14	5			
MAR 21	242	318	298	227	74	33	8	4				
APR 1	220	291	268	168	45	23	9	9				
APR 11	220	245	223	141	36	18	5					
APR 21	220	177	159	95	45	32	18	5				
MAY 1	220	116	114	95	36	23	5	5	5			
MAY 11	220	55	50	32	9							
MAY 21	242	45	45	41	12	4						
JUN 1	220	9	9	9								
JUN 11	220	14	14	14								
JUN 21	220	14	14	9	5	5						
JUL 1	220											
JUL 11	220											
JUL 21	242											
AUG 1	220											
AUG 11	220											
AUG 21	242											
SEP 1	220											
SEP 11	220	23	23	14								
SEP 21	220	36	36	5	5							
OCT 1	220	50	50	32	9	5	5					
OCT 11	220	59	55	36	18	14	9	5	5			
OCT 21	242	136	136	99	33	12	4	4	4			
NOV 1	220	168	164	82	23	9	5	5	5	5		
NOV 11	220	241	236	136	41	23	14	5	5			
NOV 21	220	409	395	286	145	59	27	14				
DEC 1	220	405	377	268	95	64	36	23	9	5		
DEC 11	220	350	323	223	91	36	27	5	5			
DEC 21	242	401	368	269	124	54	25	17				
MONTH												
JAN	682	390	358	248	142	65	34	18	9	3		
FEB	622	307	288	186	84	27	8	6	6	2		
MAR	682	320	298	223	92	40	15	7	3	1	1	
APR	660	238	217	135	42	24	11	5				
MAY	682	72	69	56	19	9	1	1	1			
JUN	660	12	12	11	2	2						
JUL	682											
AUG	682											
SEP	660	20	20	6	2							
OCT	682	84	82	57	21	10	6	3	3			
NOV	660	273	265	168	70	30	15	8	3	2		
DEC	682	386	356	254	104	51	29	15	4	1		

Table 20—Monthly average temperatures, °F, in or adjacent to RNR; based on or adjusted to 30-year normal period 1951-80. Mean is arithmetic average of maximum and minimum values. Based on 24-hour periods ending at morning (A), generally near 0800, or afternoon (P), generally 1600 to 1700, observation time (obt.). Adj. denotes adjustment of shorter-period averages. (f) denotes former station, not continuing through year 1985; (o), old station, closed before 1930

Station, elev., obt.			Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
									°F						
Big Creek 1 S	(f)	Max.	32.1	38.2	42.2	50.0	61.5	70.0	81.2	79.7	70.3	57.9	41.2	33.2	54.8
5,686 P		Min.	7.0	11.2	13.2	21.7	28.5	34.0	36.3	34.1	28.7	23.0	16.0	8.9	21.9
Adj.		Mean	19.6	24.7	27.7	35.9	45.0	52.0	58.8	56.9	49.5	40.5	28.6	21.1	38.4
Blackbird Mine	(f)	Max.	26.3	31.5	36.3	44.7	54.8	64.0	76.0	73.7	63.0	49.5	34.5	27.8	48.5
6,825 A		Min.	6.8	10.0	12.0	21.0	30.2	37.0	42.5	41.2	34.0	25.5	16.0	9.2	23.8
Adj.		Mean	16.6	20.8	24.2	32.9	42.5	50.5	59.3	57.5	48.5	37.5	25.3	18.5	36.2
Bonanza G.S.		Max.							78.7	76.8	69.0				
6,376 P		Min.							37.5	35.7	29.5				
Adj.		Mean							58.1	56.3	49.3				
Campbell's Ferry		Max.	34.9	43.3	51.2	60.9	70.2	79.8	92.0	91.0	79.1	62.3	45.9	36.3	62.2
2,310 A		Min.	19.2	23.2	26.3	33.4	40.2	46.7	51.8	50.8	44.6	35.0	27.4	22.4	35.1
Adj.[1]		Mean	27.1	33.3	38.8	47.2	55.2	63.3	71.9	70.9	61.9	48.7	36.7	29.4	48.7
Cascade 1 NW		Max.	29.8	35.8	41.3	51.4	62.7	71.5	82.8	80.6	71.1	58.0	40.8	31.7	54.8
4,896 P[2]		Min.	12.4	15.1	18.3	27.0	34.2	40.7	45.3	43.0	35.8	29.1	22.7	15.8	28.3
		Mean	21.1	25.5	29.8	39.2	48.5	56.1	64.1	61.8	53.5	43.6	31.8	23.8	41.6
Challis		Max.	30.4	38.0	45.9	57.2	67.3	76.0	86.6	83.7	74.4	61.7	43.5	32.8	58.2
5,175 P[3]		Min.	10.4	16.2	21.8	30.4	38.5	45.4	50.9	48.7	40.9	31.8	21.6	13.3	30.8
		Mean	20.4	27.3	33.8	43.8	52.9	60.7	68.7	66.2	57.6	46.8	32.5	23.2	44.5
Cobalt		Max.	29.7	38.2	45.0	55.6	65.5	73.8	84.3	82.0	73.0	60.4	41.6	31.2	56.7
5,010 P		Min.	6.2	11.7	16.4	25.2	32.1	38.6	42.4	40.7	34.2	26.8	18.5	10.2	25.3
Adj.		Mean	18.0	25.0	30.7	40.4	48.8	56.2	63.4	61.4	53.6	43.6	30.1	20.7	41.0
Darby, MT		Max.	34.9	42.2	47.5	57.1	66.4	74.1	83.9	82.1	72.0	60.8	45.1	38.1	58.7
3,880 P		Min.	16.9	22.0	24.1	30.5	37.7	43.7	47.0	45.9	39.5	32.5	24.5	20.3	32.1
		Mean	25.9	32.1	35.8	43.8	52.1	58.9	65.5	64.0	55.8	46.7	34.8	29.2	45.4
Deadwood Dam	(f)	Max.	30.1	38.2	42.7	51.2	62.4	71.6	82.8	81.6	72.5	59.3	41.1	31.3	55.4
5,375 P		Min.	7.7	10.2	12.7	21.3	28.7	35.7	39.6	37.7	31.8	26.2	19.6	10.6	23.5
Adj.		Mean	18.9	24.2	27.7	36.3	45.6	53.7	61.2	59.7	52.2	42.8	30.4	21.0	39.5
Dixie		Max.	29.2	34.6	37.3	45.1	55.5	65.0	76.1	75.3	65.9	53.5	38.0	30.9	50.5
5,620 A[4]		Min.	3.4	7.0	10.1	20.3	28.0	34.3	37.2	35.0	29.1	22.4	13.4	6.5	20.6
Adj.		Mean	16.3	20.8	23.7	32.7	41.8	49.7	56.7	55.2	47.5	38.0	25.7	18.7	35.6
Elk City		Max.	33.6	40.7	43.9	52.2	61.7	70.1	81.1	80.3	70.8	58.9	43.2	35.1	56.0
4,058 A		Min.	9.2	14.3	16.8	25.6	32.7	38.8	40.5	38.3	33.1	26.7	20.1	12.6	25.7
Adj.		Mean	21.4	27.5	30.4	38.9	47.2	54.5	60.8	59.3	52.0	42.8	31.7	23.9	40.9
Elk Creek G.S.	(f)	Max.							77.3	75.0	66.0				
6,426 P		Min.							34.5	32.0	25.7				
Adj.[1]		Mean							55.9	53.5	45.9				
Gibbonsville		Max.	28.5	36.6	45.0	56.8	66.7	75.3	86.2	83.7	74.3	60.2	41.2	31.0	57.1
4,480 P		Min.	8.6	13.7	19.0	27.0	33.3	39.7	44.2	42.7	35.8	28.2	20.5	12.4	27.1
Adj.		Mean	18.6	25.2	32.0	41.9	50.0	57.5	65.2	63.2	55.1	44.2	30.9	21.7	42.1
Grangeville		Max.	36.5	42.3	46.5	54.9	63.5	71.4	82.3	81.5	71.9	59.3	44.8	38.8	57.8
3,355 P[5]		Min.	20.1	24.5	26.1	31.9	38.4	44.9	50.0	48.7	41.7	34.0	26.8	22.8	34.2
		Mean	28.3	33.4	36.3	43.4	51.0	58.2	66.2	65.1	56.8	46.7	35.8	30.8	46.0
Grangeville 11 SE		Max.	37.0	45.3	50.8	59.8	67.7	75.5	86.0	85.6	76.0	62.3	46.1	38.2	60.9
2,250 P		Min.	22.5	27.2	29.3	34.8	40.7	46.8	51.0	49.3	43.1	36.2	29.7	25.2	36.3
Adj.		Mean	29.8	36.3	40.1	47.3	54.2	61.2	68.5	67.5	59.6	49.3	37.9	31.7	48.6

(con.)

Table 20 (Con.)

Station, elev., obt.		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
		°F												
Indianola R.S.	Max.					70.7	79.9	90.8	88.7	78.0				
3,450 P	Min.					38.0	45.2	50.0	48.3	40.9				
Adj.	Mean					54.4	62.6	70.4	68.5	59.5				
Krassel R.S.	Max.					68.0	77.5	88.8	86.3	76.3				
3,600 P	Min.					36.6	40.8	44.4	42.2	35.9				
Adj.	Mean					52.3	59.2	66.6	64.3	56.1				
Landmark R.S. (f)	Max.							76.5	74.5	66.0				
6,680 P	Min.							32.9	30.6	25.1				
Adj.	Mean							54.7	52.6	45.6				
Little Creek G.S.	Max.						77.5	88.7	85.5	76.2				
4,400 P	Min.						41.5	47.0	45.5	38.3				
Adj.	Mean						59.5	67.9	65.5	57.3				
Loon Creek (o)	Max.	31.5	37.7	43.0	51.0	61.0	70.7	81.2	78.5	69.5	59.0	41.0	31.5	54.6
5,810 P	Min.	7.2	10.2	14.8	23.0	29.0	35.3	39.3	37.0	30.3	23.5	16.0	9.0	22.9
Adj.	Mean	19.4	24.0	28.9	37.0	45.0	53.0	60.3	57.8	49.9	41.3	28.5	20.3	38.8
McCall	Max.	29.8	35.3	39.8	49.0	60.2	69.8	81.0	79.1	69.7	57.3	40.8	31.7	53.6
5,025 P	Min.	12.2	14.4	16.8	25.6	33.7	40.3	44.6	42.2	35.9	29.1	22.5	16.0	27.8
	Mean	21.0	24.9	28.3	37.3	47.0	55.1	62.8	60.7	52.8	43.2	31.7	23.9	40.7
Middle Fork Lodge	Max.	33.2	40.5	46.7	56.5	66.2	75.3	86.6	84.4	75.4	62.1	44.1	35.0	58.8
4,480 A	Min.	13.0	16.0	20.6	28.4	34.8	41.1	45.6	43.5	36.6	29.4	22.1	15.7	28.9
Adj.	Mean	23.1	28.3	33.7	42.5	50.5	58.2	66.1	64.0	56.0	45.8	33.1	25.4	43.9
New Meadows R.S.	Max.	30.5	37.5	43.7	54.0	64.8	73.8	84.9	82.4	73.0	60.1	43.2	32.4	56.7
3,870 A[6]	Min.	8.4	12.1	16.4	26.4	33.1	39.3	42.4	40.0	32.4	24.8	19.6	11.7	25.6
	Mean	19.5	24.8	30.1	40.2	49.0	56.6	63.7	61.2	52.7	42.5	31.4	22.1	41.2
Riggins R.S.	Max.	41.4	49.4	55.9	65.2	73.7	82.1	93.0	91.9	82.0	67.8	51.2	43.0	66.4
1,800 P	Min.	27.5	31.3	33.7	38.6	45.9	52.6	59.1	58.1	50.8	42.2	34.0	30.0	42.0
	Mean	34.5	40.4	44.8	51.9	59.8	67.4	76.1	75.0	66.4	55.0	42.6	36.5	54.2
Roosevelt (o)	Max.	29.0	34.0	36.8	42.0	50.0	61.0	71.0	70.0	61.3	51.0	37.8	30.8	47.8
7,500 P	Min.	9.5	13.0	15.3	21.0	28.5	36.5	42.5	41.5	35.7	27.5	18.5	11.8	25.1
Adj.[1]	Mean	19.3	23.5	26.1	31.5	39.3	48.8	56.8	55.8	48.5	39.3	28.2	21.3	36.5
Salmon-Salmon 1 N	Max.	30.1	38.8	48.2	60.0	69.7	77.8	88.5	85.8	75.4	61.8	43.8	33.2	59.4
3,940 P[7]	Min.	9.4	16.6	22.6	30.3	38.1	44.7	49.1	47.0	38.8	29.5	21.3	14.1	30.1
	Mean	19.8	27.7	35.4	45.2	53.9	61.3	68.8	66.4	57.1	45.7	32.6	23.7	44.8
Shoup	Max.	30.3	39.1	48.6	60.6	70.5	78.4	88.6	85.8	75.5	60.6	42.2	32.5	59.4
3,400 P	Min.	15.2	20.4	25.2	32.8	39.0	45.4	50.7	49.2	41.8	33.6	26.0	19.1	33.2
Adj.	Mean	22.8	29.8	36.9	46.7	54.8	61.9	69.7	67.5	58.7	47.1	34.1	25.8	46.3
Slate Crk. R.S. (f)	Max.	43.5	50.0	55.2	65.0	73.5	82.0	94.2	93.1	83.3	68.5	51.6	44.6	67.0
1,568 P	Min.	28.0	31.2	33.5	37.4	43.6	49.9	55.3	54.8	47.0	39.0	32.0	30.0	40.2
Adj.	Mean	35.8	40.6	44.4	51.2	58.6	66.0	74.8	74.0	65.2	53.8	41.8	37.3	53.6
Stibnite (f)	Max.	31.0	36.0	39.0	46.5	57.0	66.2	77.0	75.2	66.2	55.0	40.3	32.8	51.8
6,550 A	Min.	8.2	11.0	13.0	22.0	29.0	35.7	41.5	40.5	34.3	26.0	18.2	11.0	24.2
Adj.[1]	Mean	19.6	23.5	26.0	34.3	43.0	51.0	59.3	57.9	50.3	40.5	29.3	21.9	38.0
Taylor Ranch	Max.	28.2	37.0	45.3	56.5	66.5	75.3	86.7	84.2	73.5	58.5	40.5	30.0	56.9
3,835 A	Min.	14.3	18.3	22.8	30.8	37.0	43.0	47.2	45.0	38.3	31.0	23.8	17.2	30.7
Adj.[1]	Mean	21.3	27.7	34.1	43.7	51.8	59.2	67.0	64.6	55.9	44.8	32.2	23.6	43.8
Warren	Max.	31.8	37.6	40.2	47.8	58.1	67.0	77.6	75.3	67.3	56.0	39.9	32.5	52.6
5,899 P	Min.	6.0	9.2	10.4	19.4	27.0	32.8	35.6	33.5	28.7	23.0	15.3	9.2	20.9
Adj.	Mean	18.9	23.4	25.3	33.6	42.6	49.9	56.6	54.4	48.0	39.5	27.6	20.9	36.8
Yellow Pine 7 S	Max.	32.0	38.3	42.3	50.5	60.8	69.4	80.9	78.7	69.8	57.8	41.3	33.2	54.6
5,070 A	Min.	8.2	11.3	13.9	22.8	29.8	35.6	39.4	37.2	31.0	25.1	18.2	11.7	23.7
Adj.	Mean	20.1	24.8	28.1	36.7	45.3	52.5	60.2	58.0	50.4	41.5	29.8	22.5	39.2

[1] Adjustment calculations based on less than 10 years of data.
[2] A during 1955-61 and beginning in 1980.
[3] Changed to A in 1973.
[4] P prior to 1966; data not used in averaging.
[5] Late evening observation time.
[6] P prior to 1955.
[7] Station moved in 1968; changed from midnight to P.

Table 21—Daily maximum and minimum temperature statistics (°F). Based on indicated years of record, 1951-80 where available, and on 24-hour observation period ending mostly about 1600 or 1700 m.s.t.; 0800 at Dixie and Middle Fork Lodge, 1300 at fire-weather stations in Intermountain Region. Letter M following year of highest or lowest average denotes occurrence of missing data; average shown is based on at least 7 days of data during 10 (or 11)-day period. "Median low" extreme daily value of –1.0 denotes actual value of –1.0 or lower.

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 100835 BIG CREEK 1 S — 1949-1967

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	16	31.5	4.5	31.0	38.4 63	24.5 50	48 64	39.9	5.2	39.5	5 59	21.5	6.9	21.5	JAN 1
JAN 11	16	31.1	6.2	30.0	42.3 61	20.5 60	50 53	39.2	6.4	38.0	5 63	21.7	8.0	23.0	JAN 11
JAN 21	17	32.4	5.1	33.0	39.8 53	22.0 57	51 62	42.2	5.3	42.0	5 62	20.3	7.3	22.0	JAN 21
FEB 1	18	37.0	6.7	37.5	48.3 63	22.2 49	59 62	44.8	6.5	44.0	10 50	28.9	8.4	31.0	FEB 1
FEB 11	17	36.2	4.8	35.0	46.0 57	29.0 56	57 58	45.1	5.0	44.0	17 56	27.9	6.5	28.0	FEB 11
FEB 21	17	38.3	6.8	40.0	47.9 63	23.9 62	58 58	46.5	8.5	47.0	12 62	30.6	7.4	33.0	FEB 21
MAR 1	17	38.1	3.8	37.0	44.3 65	31.9 56	58 53	47.7	5.7	48.0	20 66	28.9	4.6	30.0	MAR 1
MAR 11	17	40.9	3.2	40.0	46.1 60	34.6 55	65 60	50.9	5.7	50.0	22 55	30.9	4.9	31.0	MAR 11
MAR 21	17	44.7	4.2	44.0	53.0 60	38.4 55	65 60	56.1	5.1	57.0	24 65	33.4	3.8	33.0	MAR 21
APR 1	17	48.0	4.7	46.0	59.6 60	42.0 53	68 60	57.0	6.5	56.0	32 63	37.9	3.4	38.0	APR 1
APR 11	18	50.5	6.2	48.5	65.7 62	41.3 55	73 62	59.9	6.9	61.0	32 60	39.9	5.9	39.0	APR 11
APR 21	18	51.7	5.5	52.0	64.4 52	40.8 67	72 52	62.7	6.0	62.0	34 67	40.8	6.0	38.5	APR 21
MAY 1	18	56.2	6.5	55.5	71.8 66	45.5 64	80 54	68.0	7.2	67.0	34 64	45.1	6.7	43.0	MAY 1
MAY 11	17	61.6	5.2	61.0	72.5 54	53.1 62	84 54	73.6	6.7	75.0	40 67	47.8	6.0	46.0	MAY 11
MAY 21	18	64.0	6.7	63.0	77.6 58	54.5 59	85 58	74.7	5.7	74.0	42 53	51.6	6.6	50.5	MAY 21
JUN 1	18	66.2	6.1	64.5	76.6 52	57.7 54	86 56	76.2	6.4	76.5	46 66	54.6	8.1	52.5	JUN 1
JUN 11	18	68.8	5.9	68.0	81.8 61	59.8 64	88 61	79.1	5.0	79.5	49 57	57.2	6.5	57.0	JUN 11
JUN 21	18	71.5	5.0	70.0	82.7 61	62.7 63	92 55	81.7	5.8	82.0	48 64	58.9	7.3	57.0	JUN 21
JUL 1	18	77.7	4.5	79.0	82.2 60	64.1 55	95 59	86.6	5.4	87.0	56 55	66.8	6.1	68.0	JUL 1
JUL 11	18	81.9	4.6	82.0	91.4 60	74.5 63	97 60	88.9	4.1	90.0	63 65	73.0	6.6	72.5	JUL 11
JUL 21	18	82.9	3.3	81.5	89.1 60	78.2 50	97 60	90.4	3.5	90.0	57 50	72.9	6.4	72.0	JUL 21
AUG 1	19	82.1	3.8	82.0	90.3 61	74.4 62	97 61	89.1	3.6	90.0	62 50	73.5	6.3	74.0	AUG 1
AUG 11	19	81.9	4.0	83.0	88.3 67	73.6 54	94 61	88.3	3.1	88.0	60 64	73.7	7.2	75.0	AUG 11
AUG 21	19	74.9	5.6	73.0	84.7 67	66.1 51	92 61	84.9	4.8	86.0	44 56	61.5	10.4	64.0	AUG 21
SEP 1	17	75.1	5.6	75.0	86.1 55	64.7 65	93 55	83.9	5.0	84.0	48 64	63.8	8.2	64.0	SEP 1
SEP 11	16	69.4	6.4	68.5	79.3 53	54.5 65	89 53	82.5	4.9	83.0	45 65	54.7	6.6	54.5	SEP 11
SEP 21	17	67.7	8.7	69.0	80.5 67	50.1 59	85 52	77.7	6.3	81.0	41 59	54.4	10.5	54.0	SEP 21
OCT 1	16	63.6	6.6	64.0	76.3 52	51.1 57	81 58	75.3	3.4	75.5	38 61	49.3	10.6	47.0	OCT 1
OCT 11	16	58.8	5.8	58.5	67.9 58	48.5 51	79 58	68.6	5.4	67.5	35 66	45.1	6.4	45.0	OCT 11
OCT 21	16	52.0	7.1	51.0	63.9 52	39.3 56	71 52	62.4	6.5	65.0	30 55	40.6	8.6	39.0	OCT 21
NOV 1	17	46.7	4.6	45.0	57.3 54	41.3 63	66 65	56.5	5.5	56.0	29 56	37.2	5.4	38.0	NOV 1
NOV 11	17	39.7	5.6	39.0	50.0 54	25.3 55	57 56	49.9	5.9	51.0	7 55	29.3	7.6	31.0	NOV 11
NOV 21	17	38.1	4.0	37.0	45.2 54	29.7 52	67 65	48.5	8.2	48.0	20 67	29.5	4.5	29.0	NOV 21
DEC 1	18	34.0	3.6	33.0	40.8 65	28.9 51	54 56	42.2	5.2	42.0	15 66	24.6	5.4	25.0	DEC 1
DEC 11	16	33.0	4.8	33.5	37.6 58	21.6 64	47 58	40.5	4.2	40.5	-1 64	22.9	8.9	26.0	DEC 11
DEC 21	16	32.1	2.8	32.0	35.4 58	25.9 51	49 62	40.1	3.7	40.0	14 52	22.6	4.1	22.5	DEC 21
MONTH															MONTH
JAN	16	31.7	3.6	31.0	38.9 53	24.7 50	51 62	44.9	4.4	46.0	5 63	15.8	7.1	17.5	JAN
FEB	17	37.0	4.1	37.0	45.6 63	31.3 66	59 62	50.2	5.9	50.0	10 50	23.2	7.3	23.0	FEB
MAR	17	41.4	2.2	41.0	46.1 60	36.6 55	65 60	56.8	4.3	57.0	20 66	27.1	4.0	27.0	MAR
APR	17	50.4	3.6	49.0	57.4 52	45.4 55	73 62	65.1	4.4	64.0	32 63	36.1	2.9	36.0	APR
MAY	17	60.3	4.1	58.0	70.9 58	54.7 59	85 58	77.0	5.0	78.0	34 64	42.0	4.4	42.0	MAY
JUN	18	68.8	3.4	68.0	78.9 61	64.4 64	92 55	84.5	3.1	84.0	46 66	50.9	4.7	49.5	JUN
JUL	18	80.9	2.9	80.5	87.6 60	76.7 55	97 60	91.7	3.1	91.5	56 55	64.9	5.7	65.0	JUL
AUG	19	79.5	3.4	79.0	85.9 61	74.7 65	97 61	90.5	2.6	91.0	44 56	60.7	9.9	61.0	AUG
SEP	16	70.3	5.1	71.5	77.1 52	60.7 65	93 55	84.7	5.1	85.0	41 59	49.8	6.4	49.5	SEP
OCT	16	57.9	4.8	57.0	68.4 52	51.3 51	81 58	75.5	3.4	76.0	30 55	37.4	4.4	37.5	OCT
NOV	17	41.5	3.5	40.0	50.8 54	34.3 55	67 65	57.4	5.1	56.0	7 55	25.5	5.9	27.0	NOV
DEC	16	33.0	2.5	32.5	37.8 58	29.0 64	54 56	44.3	3.6	43.5	-1 64	17.9	6.7	19.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 100835 BIG CREEK 1 S — 1949-1967

		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	16	6.2	7.8	6.0	17.8 53	-9.3 58	32 61	23.9	7.6	27.0	-33 59	-15.1	12.6	-1.0	JAN 1
JAN 11	16	8.7	10.5	9.5	27.9 53	-10.3 60	35 59	24.6	7.7	26.0	-35 60	-11.9	14.0	-1.0	JAN 11
JAN 21	17	7.2	9.3	11.0	22.8 53	-12.1 57	32 50	26.4	6.2	29.0	-41 56	-14.8	15.6	-1.0	JAN 21
FEB 1	18	9.5	8.3	9.5	22.2 61	-9.3 56	33 61	25.6	6.4	27.0	-40 56	-10.8	11.4	-1.0	FEB 1
FEB 11	17	11.7	7.1	9.0	23.7 61	-3.0 55	34 49	27.1	4.1	27.0	-38 56	-9.8	13.6	-1.0	FEB 11
FEB 21	17	9.7	9.9	13.0	21.6 57	-9.1 60	32 63	25.3	5.7	26.0	-36 62	-8.1	14.1	-1.0	FEB 21
MAR 1	17	9.7	5.3	10.0	19.6 57	-1.2 65	36 57	26.1	4.9	27.0	-36 55	-10.2	11.3	-1.0	MAR 1
MAR 11	17	11.0	7.3	11.0	25.4 49	-0.9 65	31 61	25.9	3.7	26.0	-25 65	-10.2	10.5	-1.0	MAR 11
MAR 21	17	17.0	4.7	17.0	24.9 63	8.1 55	33 67	29.3	2.5	30.0	-20 55	0.8	9.9	3.0	MAR 21
APR 1	17	19.7	3.7	20.0	24.5 54	13.0 52	33 66	30.2	2.8	31.0	-3 52	8.1	6.4	7.0	APR 1
APR 11	18	21.4	2.5	21.0	25.3 57	14.3 64	34 58	29.9	2.7	30.5	2 67	10.3	4.1	11.5	APR 11
APR 21	18	24.1	2.3	24.0	28.3 59	20.2 67	39 59	32.2	3.0	31.5	2 65	15.0	5.0	15.5	APR 21
MAY 1	18	26.8	3.2	26.0	31.5 52	21.8 65	42 54	34.4	4.1	34.5	5 67	19.1	5.4	19.5	MAY 1
MAY 11	17	28.7	3.0	27.0	35.2 57	25.2 67	43 49	35.4	3.7	35.0	17 65	22.2	3.0	22.0	MAY 11
MAY 21	18	30.5	2.5	29.5	35.5 56	26.8 54	43 63	39.2	2.6	39.0	14 60	22.6	3.9	22.5	MAY 21
JUN 1	18	33.3	3.1	34.0	37.8 52	28.0 65	48 57	40.6	4.1	40.5	19 55	26.2	3.4	27.0	JUN 1
JUN 11	18	33.9	2.7	33.0	38.3 63	29.9 52	47 54	41.6	3.6	42.0	21 54	27.3	3.5	27.5	JUN 11
JUN 21	18	34.6	3.5	34.0	41.6 65	28.9 53	52 52	43.3	4.7	41.0	20 49	27.5	3.2	27.0	JUN 21
JUL 1	18	34.9	2.5	33.5	39.6 50	31.0 59	51 61	43.0	3.6	42.5	22 55	27.4	3.3	27.0	JUL 1
JUL 11	18	36.5	3.3	35.0	43.9 54	31.5 63	55 54	43.9	4.7	42.5	24 62	29.5	3.2	29.5	JUL 11
JUL 21	18	36.2	3.0	35.5	41.0 56	30.5 63	55 66	47.0	6.2	48.0	24 59	28.5	3.0	29.0	JUL 21
AUG 1	19	35.9	3.1	35.0	41.7 51	31.4 56	54 52	46.6	4.2	45.0	25 56	29.3	2.1	30.0	AUG 1
AUG 11	19	34.5	3.1	33.0	40.6 58	28.2 57	54 58	44.1	5.7	44.0	24 66	28.7	2.7	28.0	AUG 11
AUG 21	19	33.2	3.1	33.0	38.7 50	27.6 55	54 50	42.9	6.0	43.0	19 60	26.2	3.4	26.0	AUG 21
SEP 1	17	30.5	3.6	30.0	38.7 67	25.2 62	50 63	39.7	5.7	39.0	17 62	22.6	3.9	22.0	SEP 1
SEP 11	17	29.3	3.3	28.0	36.6 63	25.0 64	47 59	39.2	4.4	38.0	12 65	21.4	4.2	23.0	SEP 11
SEP 21	17	27.1	2.9	27.0	33.8 67	22.4 61	42 67	35.4	3.9	36.0	15 56	20.0	3.6	19.0	SEP 21
OCT 1	16	25.5	3.5	25.0	33.0 63	18.5 54	42 51	35.5	5.0	37.5	10 54	17.8	4.0	18.5	OCT 1
OCT 11	16	24.7	3.7	25.0	30.4 62	17.8 52	40 55	34.3	3.9	34.5	10 66	16.3	4.0	18.0	OCT 11
OCT 21	16	21.5	2.5	21.0	25.5 59	16.6 53	41 59	32.0	4.8	31.5	5 61	12.6	4.0	12.0	OCT 21
NOV 1	17	17.1	5.5	17.0	27.9 58	8.5 52	36 58	28.7	4.9	29.0	-10 56	5.1	8.0	5.0	NOV 1
NOV 11	17	17.4	8.4	19.0	29.3 54	3.6 55	40 53	31.0	5.0	31.0	-28 55	0.5	15.9	3.0	NOV 11
NOV 21	17	13.1	7.8	14.0	23.2 53	-7.5 52	41 60	27.9	7.8	29.0	-19 52	-4.9	9.0	-1.0	NOV 21
DEC 1	18	10.6	5.9	9.5	21.1 58	-0.3 60	31 65	26.1	3.2	26.5	-25 51	-9.4	9.6	-1.0	DEC 1
DEC 11	16	10.4	7.2	13.5	17.4 62	-6.4 54	31 66	27.0	4.3	29.0	-42 64	-13.5	12.2	-1.0	DEC 11
DEC 21	16	6.9	6.2	4.5	20.4 64	-1.1 52	37 64	24.8	5.8	24.0	-28 51	-13.8	9.2	-1.0	DEC 21
MONTH															MONTH
JAN	16	7.2	7.1	5.0	22.8 53	-4.8 57	35 59	29.9	2.8	30.0	-41 56	-25.0	12.2	-1.0	JAN
FEB	17	10.2	5.4	11.0	21.1 61	1.6 55	34 49	30.4	2.4	31.0	-40 56	-18.9	12.4	-1.0	FEB
MAR	17	12.7	4.1	14.0	16.6 61	2.8 65	36 57	30.4	2.6	30.0	-36 55	-16.2	7.2	-1.0	MAR
APR	17	21.9	1.7	22.0	25.0 66	18.5 55	39 59	33.3	2.1	33.0	-3 52	5.7	4.9	7.0	APR
MAY	17	28.6	2.1	27.0	32.1 57	25.7 50	43 63	39.2	2.6	39.0	5 67	17.7	4.8	19.0	MAY
JUN	18	33.9	2.0	34.0	37.5 58	30.2 60	52 52	44.7	3.9	44.5	19 55	24.0	2.5	25.0	JUN
JUL	18	35.9	1.9	35.5	38.8 67	32.2 63	55 66	49.3	4.9	49.0	22 55	25.9	2.0	26.0	JUL
AUG	19	34.5	2.3	33.0	38.3 50	31.0 57	54 58	49.1	4.0	49.0	19 60	25.6	3.1	25.0	AUG
SEP	17	29.0	2.7	28.0	35.6 63	26.2 56	50 63	42.2	4.1	43.0	12 65	17.9	3.4	18.0	SEP
OCT	16	23.8	2.6	23.5	28.5 63	18.9 52	42 51	37.5	3.3	38.0	5 61	11.7	3.2	12.0	OCT
NOV	17	15.9	4.6	17.0	22.1 53	6.5 56	41 60	33.9	3.9	34.0	-28 55	-11.4	7.7	-1.0	NOV
DEC	16	9.1	3.9	9.0	18.0 58	2.3 54	37 64	29.3	3.3	29.5	-42 64	-21.3	9.1	-1.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101663 CHALLIS 1951-1980

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	30	27.1	8.3	28.0	40.2 69	5.9 74	54 69	38.5	8.0	39.0	-1 79	14.8	9.4	15.0	JAN 1
JAN 11	30	32.5	7.0	34.0	45.4 53	18.4 60	55 61	42.9	6.6	44.0	-5 63	20.8	9.7	20.5	JAN 11
JAN 21	30	31.4	7.2	31.5	45.1 53	15.8 79	59 71	43.6	6.3	42.0	-5 62	18.7	10.8	22.0	JAN 21
FEB 1	30	36.2	6.6	35.0	52.4 63	16.2 56	59 63	45.6	6.4	44.5	-4 56	25.9	10.6	28.0	FEB 1
FEB 11	30	38.5	5.8	38.5	53.7 77	28.2 56	58 77	48.0	5.6	49.0	14 56	29.7	7.2	29.5	FEB 11
FEB 21	29	39.6	7.5	40.0	51.9 54	19.8 60	61 54	47.3	6.3	48.0	10 60	32.0	8.6	34.0	FEB 21
MAR 1	30	41.1	5.7	42.0	53.6 68	31.3 52	68 72	50.3	7.0	50.0	11 60	31.5	7.6	29.5	MAR 1
MAR 11	30	44.9	4.9	43.0	59.4 72	38.7 52	67 72	54.4	5.3	54.0	26 65	35.1	6.4	34.5	MAR 11
MAR 21	30	51.1	5.8	51.0	63.5 78	38.1 75	73 66	61.2	6.4	61.5	23 75	40.4	6.4	39.5	MAR 21
APR 1	29	54.7	5.5	53.0	67.0 60	41.5 75	77 77	64.1	7.2	65.0	36 75	44.6	5.2	44.0	APR 1
APR 11	30	57.4	5.9	57.0	73.8 62	46.7 70	81 62	67.3	5.9	67.0	36 66	46.8	6.2	45.5	APR 11
APR 21	30	59.6	6.2	60.0	76.3 77	48.3 67	85 77	70.6	7.0	71.5	38 67	48.5	6.2	46.5	APR 21
MAY 1	30	64.7	6.2	65.0	82.7 66	52.9 75 M	89 66	75.1	5.8	75.0	42 65	52.6	6.6	53.5	MAY 1
MAY 11	30	67.2	5.8	66.0	79.4 54	53.0 74	90 54	78.6	5.8	79.5	45 74	54.3	6.7	53.0	MAY 11
MAY 21	29	69.7	5.8	69.0	82.5 66	60.1 59 M	93 66	80.5	5.6	80.0	46 80	57.4	6.6	56.0	MAY 21
JUN 1	30	73.2	6.5	73.0	83.2 69	60.4 51	93 69	82.4	5.8	83.0	50 51	62.9	7.3	62.0	JUN 1
JUN 11	30	75.8	5.5	76.0	90.5 74	67.0 64	95 74	84.8	5.0	84.0	52 57	64.9	6.7	64.5	JUN 11
JUN 21	30	79.2	6.0	79.0	91.3 74	63.7 69	98 74	89.2	5.4	90.5	51 69	66.3	7.5	65.5	JUN 21
JUL 1	30	83.9	5.2	85.0	92.4 75	69.3 55	99 73	91.1	4.7	92.0	61 78	73.5	7.4	74.5	JUL 1
JUL 11	30	87.4	3.2	87.0	95.3 60	81.8 52	102 60	93.5	3.3	94.0	67 80	77.9	6.8	78.5	JUL 11
JUL 21	30	88.3	3.2	87.0	93.7 66	81.5 77	103 64	94.7	3.3	94.5	62 77	79.3	7.0	80.5	JUL 21
AUG 1	29	86.5	4.6	87.0	94.1 61	75.6 76	103 61	93.2	3.6	94.0	61 74	78.4	7.1	81.0	AUG 1
AUG 11	29	84.3	6.1	85.0	91.6 67	70.4 68	98 69	91.4	3.8	92.0	58 78	75.3	9.7	80.0	AUG 11
AUG 21	29	80.5	5.5	79.0	90.8 67	71.6 51	99 69	89.2	4.7	89.0	58 60	69.5	8.0	66.0	AUG 21
SEP 1	30	79.0	3.8	79.0	87.6 55	72.4 65	93 69	86.9	3.2	86.5	56 73	67.7	5.6	69.0	SEP 1
SEP 11	30	73.1	5.4	73.0	82.2 56	57.2 78	91 73	83.8	4.3	84.0	40 65	60.5	8.4	61.0	SEP 11
SEP 21	30	71.0	6.6	71.5	83.2 67	57.1 59	90 66	79.5	5.6	81.0	44 71	59.6	8.8	62.0	SEP 21
OCT 1	30	68.0	5.4	68.0	76.7 79	57.6 77	83 65	77.1	4.3	78.0	44 59	55.4	7.6	53.0	OCT 1
OCT 11	28	62.4	4.9	63.0	70.3 58	49.4 69	80 71	72.5	4.6	72.5	41 69	50.6	5.5	51.0	OCT 11
OCT 21	29	55.3	5.5	55.0	66.5 62	47.0 75	72 78	65.8	5.0	68.0	27 71	45.2	7.2	45.0	OCT 21
NOV 1	29	49.3	5.0	49.0	62.2 65	39.6 73	67 80	57.9	5.4	58.0	24 73	39.7	7.3	40.0	NOV 1
NOV 11	29	42.6	5.9	42.0	54.1 54	27.2 55	65 54	53.4	6.1	53.0	9 55	32.5	7.8	32.0	NOV 11
NOV 21	29	38.5	5.0	39.0	46.2 53	25.9 52	58 59	48.4	5.6	50.0	12 75	27.9	6.7	30.0	NOV 21
DEC 1	29	35.7	4.2	35.0	45.0 75	26.3 78	55 51	44.8	5.3	43.0	2 72	25.6	6.9	27.0	DEC 1
DEC 11	28	32.1	5.5	33.0	41.3 79	20.7 67	52 79	42.4	4.6	42.0	8 72	22.1	6.7	23.0	DEC 11
DEC 21	29	30.9	4.6	30.0	46.5 80	24.3 52	59 80	42.3	5.6	42.0	-1 78	18.9	7.3	20.0	DEC 21
MONTH															MONTH
JAN	30	30.4	5.1	30.0	42.5 53	17.1 79	59 71	46.0	6.0	46.0	-5 63	9.4	9.6	8.0	JAN
FEB	29	38.0	5.1	37.0	49.3 63	27.4 56	61 54	51.0	5.0	50.0	-4 56	22.5	10.0	24.0	FEB
MAR	30	45.9	4.0	44.0	55.1 68	39.5 52	73 66	61.8	5.7	62.0	11 60	29.8	6.6	28.5	MAR
APR	29	57.3	4.2	57.0	64.9 77	48.2 75	85 77	72.4	5.5	72.0	36 75	42.0	4.0	42.0	APR
MAY	29	67.4	4.2	67.0	77.5 66	59.5 78	93 66	82.7	4.6	83.0	42 65	49.5	5.0	48.0	MAY
JUN	30	76.0	3.6	75.0	84.5 74	69.2 51 M	98 74	90.6	3.7	91.0	50 51	58.5	4.9	58.0	JUN
JUL	30	86.6	2.7	86.0	91.4 66	81.4 55	103 64	96.0	2.7	96.0	61 78	71.1	6.6	71.5	JUL
AUG	29	83.6	4.2	82.0	90.6 69	75.9 76	103 61	94.4	2.8	94.0	58 78	68.0	8.0	65.0	AUG
SEP	30	74.4	3.9	73.5	80.6 79 M	66.5 65	93 69	87.9	2.8	88.0	40 65	55.6	7.9	55.5	SEP
OCT	28	61.6	3.4	60.5	68.5 52	55.3 69	83 65	77.9	3.1	78.5	27 71	43.7	5.5	45.0	OCT
NOV	28	43.5	3.8	43.0	51.9 54 M	37.7 55	67 80	58.9	5.0	59.0	9 55	25.4	6.7	27.5	NOV
DEC	27	32.8	3.0	33.0	39.3 80	26.8 78	59 80	47.3	4.8	47.0	-1 78	15.9	6.2	17.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101663 CHALLIS 1951-1980

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	I	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
	10-DAY AND MONTHLY PERIOD MEANS						I	10-DAY AND MONTHLY EXTREME DAILY VALUES								
JAN 1	30	7.4	9.5	7.0	22.5 66	-17.7 74	I	37 69	22.2	9.8	23.5	-27 79	-6.0	9.8	-1.0	JAN 1
JAN 11	30	13.3	8.3	14.5	31.0 53	-2.3 63	I	39 53	26.1	8.0	25.5	-24 63	-1.2	10.6	-0.5	JAN 11
JAN 21	30	10.4	9.0	10.0	26.5 70	-8.0 57	I	40 71	24.9	8.4	22.0	-32 62	-4.0	12.6	-0.5	JAN 21
FEB 1	30	13.6	7.5	13.0	29.0 63	-9.1 56	I	37 61	25.1	7.1	25.5	-28 56	1.3	11.6	4.5	FEB 1
FEB 11	29	17.9	5.7	18.0	27.1 61	2.9 52	I	38 79	29.2	6.0	31.0	-12 56	7.2	7.7	7.0	FEB 11
FEB 21	29	17.3	7.8	19.0	28.1 57	0.1 60	I	38 72	27.9	6.7	28.0	-16 62	9.0	10.3	10.0	FEB 21
MAR 1	30	18.9	5.4	19.5	27.2 80	6.4 52	I	40 54	30.3	5.3	31.5	-15 60	7.7	8.8	9.0	MAR 1
MAR 11	30	20.9	4.4	20.0	30.2 72	13.8 52	I	37 72	30.4	3.7	30.5	-3 51	10.9	7.0	11.5	MAR 11
MAR 21	30	25.2	3.8	24.5	33.1 78	16.0 75	I	45 68	34.3	3.8	34.0	3 75	16.2	6.3	16.5	MAR 21
APR 1	29	28.4	3.1	28.0	33.7 60	20.8 75	I	44 70	37.7	4.5	38.0	12 75	19.5	3.7	20.0	APR 1
APR 11	30	29.9	2.5	29.0	34.7 62	25.2 70	I	46 62	38.1	3.8	38.0	15 66	21.7	3.8	22.0	APR 11
APR 21	30	33.0	3.4	33.0	41.2 80	27.0 75	I	49 63	40.5	4.3	40.5	19 63	26.0	4.2	24.5	APR 21
MAY 1	30	36.3	3.3	36.0	43.0 80	29.3 59 M	I	52 55	43.9	3.7	44.0	16 54	28.4	4.7	28.0	MAY 1
MAY 11	30	38.1	3.1	37.5	44.6 69	31.5 74	I	57 54	46.2	4.2	46.0	22 74	30.5	4.2	31.0	MAY 11
MAY 21	29	41.0	3.2	40.0	47.6 58	35.5 53	I	56 69	49.1	2.9	49.0	26 66	33.4	4.3	34.0	MAY 21
JUN 1	30	43.8	4.1	43.0	54.6 72	34.4 51	I	59 77	50.7	3.4	50.5	28 54	36.2	5.3	34.5	JUN 1
JUN 11	30	45.6	3.0	45.0	52.3 74	39.1 76	I	58 72	52.7	2.9	52.5	30 73	37.9	4.1	38.5	JUN 11
JUN 21	30	46.8	3.6	46.0	54.0 70	41.0 76	I	62 70	53.9	3.5	53.0	28 76	38.0	5.1	38.0	JUN 21
JUL 1	30	49.0	3.0	48.0	54.1 75	42.7 55	I	68 60	56.1	4.7	55.0	31 55	41.6	4.1	41.0	JUL 1
JUL 11	30	51.7	2.3	52.0	55.6 54	47.0 52	I	64 65	57.7	3.0	58.0	39 74	45.3	3.6	45.0	JUL 11
JUL 21	30	52.0	2.3	52.0	57.2 60	45.1 51	I	64 59	58.7	3.3	58.5	38 54	45.5	3.1	45.0	JUL 21
AUG 1	29	50.6	2.8	50.0	56.3 61	45.4 62	I	65 61	58.1	3.6	58.0	38 74	44.6	4.1	45.0	AUG 1
AUG 11	29	49.4	2.9	49.0	56.5 61	44.4 78	I	66 61	56.7	3.6	57.0	34 74	43.3	4.2	44.0	AUG 11
AUG 21	29	46.2	3.0	45.0	53.5 61	41.2 60	I	67 61	54.2	4.6	54.0	32 60	38.4	4.4	37.0	AUG 21
SEP 1	30	44.2	3.2	43.0	52.6 60	38.1 64	I	60 60	51.9	4.1	51.0	30 64	36.6	4.4	36.0	SEP 1
SEP 11	30	40.8	3.4	40.0	47.5 59	32.6 65	I	60 66	49.1	3.9	48.0	17 65	32.6	5.3	32.0	SEP 11
SEP 21	30	37.7	3.5	36.5	44.7 67	30.9 61	I	52 66	44.6	3.6	45.0	22 61	30.1	4.8	29.0	SEP 21
OCT 1	30	34.9	3.1	34.0	45.0 63	29.9 77	I	55 63	43.0	4.4	42.5	20 55	27.2	4.1	28.0	OCT 1
OCT 11	28	32.4	3.4	32.0	39.5 72	22.5 69	I	50 75	41.8	5.6	41.0	11 69	24.8	4.7	25.5	OCT 11
OCT 21	29	28.3	3.1	28.0	32.4 57	22.5 51	I	50 59	38.8	4.9	39.0	1 71	19.2	5.6	19.0	OCT 21
NOV 1	29	24.9	5.1	24.0	36.8 58	17.0 52	I	52 58	35.6	6.3	36.0	2 71	15.7	6.6	16.0	NOV 1
NOV 11	29	21.7	5.9	21.0	31.7 54	9.0 55	I	41 67	32.7	4.4	33.0	-10 55	10.9	8.2	13.0	NOV 11
NOV 21	29	17.5	6.2	18.0	28.2 53	3.4 52	I	48 60	29.9	7.3	30.0	-12 79	5.8	7.8	7.0	NOV 21
DEC 1	30	14.7	6.8	14.0	25.2 75	-13.1 72 M	I	39 51	27.9	6.1	28.0	-25 72	2.3	8.9	4.5	DEC 1
DEC 11	29	13.2	6.2	14.0	23.8 69	1.5 67	I	34 77	25.0	5.4	25.0	-20 64	1.4	9.0	4.0	DEC 11
DEC 21	29	11.9	5.9	10.0	28.0 80	3.6 78	I	38 64	25.8	5.7	25.0	-24 78	-2.1	9.2	-1.0	DEC 21
MONTH							I									MONTH
JAN	30	10.4	6.5	9.5	25.3 53	-5.6 79	I	40 71	30.0	5.8	31.0	-32 62	-12.7	9.9	-1.0	JAN
FEB	28	16.3	4.8	16.0	26.1 63	5.9 52	I	38 79	32.7	4.3	33.5	-28 56	-2.4	11.6	0.5	FEB
MAR	30	21.8	3.3	21.0	28.5 68	14.5 52	I	45 68	35.4	3.3	35.5	-15 60	5.9	7.8	7.5	MAR
APR	29	30.4	2.0	30.0	33.3 65	25.5 75	I	49 63	42.1	3.5	43.0	12 75	18.7	3.3	20.0	APR
MAY	29	38.6	2.2	38.0	42.5 69	33.6 59 M	I	57 54	49.8	3.0	50.0	16 54	26.8	3.9	27.0	MAY
JUN	30	45.4	2.3	45.0	50.4 72	41.0 51 M	I	62 70	55.3	2.9	55.0	28 76	33.6	3.5	33.0	JUN
JUL	30	50.9	1.6	50.5	54.5 60	48.1 62	I	68 60	60.6	2.9	60.0	31 55	40.8	3.8	40.5	JUL
AUG	29	48.6	2.3	47.0	55.4 61	45.5 75	I	67 61	59.6	2.6	59.0	32 60	38.1	4.3	37.0	AUG
SEP	30	40.9	2.4	40.0	46.6 63	36.2 65	I	60 66	53.1	3.8	53.5	17 65	28.4	4.0	28.0	SEP
OCT	28	31.8	2.0	31.0	37.6 63	28.5 51	I	55 63	45.3	4.4	44.5	1 71	18.0	5.2	18.0	OCT
NOV	28	21.6	3.6	21.5	26.9 65	14.9 52	I	52 58	38.1	5.0	38.0	-12 79	2.8	6.7	3.0	NOV
DEC	29	13.3	3.8	13.0	20.3 80	5.4 72 M	I	39 51	31.4	3.9	31.0	-25 72	-6.8	8.5	-1.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101932 COBALT 1962-1981

		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	20	25.8	8.5	28.5	36.9 66	7.5 79	47 69	36.1	8.0	37.5	-10 79	13.7	9.7	16.0	JAN 1
JAN 11	20	32.0	6.2	34.0	39.4 67	13.7 63	55 71	41.8	6.6	43.0	0 63	20.5	7.7	20.5	JAN 11
JAN 21	20	30.2	6.5	30.0	40.8 71	18.0 63	57 71	40.6	6.6	40.5	2 62	19.3	9.1	21.0	JAN 21
FEB 1	20	35.6	4.4	35.0	42.2 62	26.3 66	53 67	45.7	3.6	45.5	12 72	26.1	7.4	28.0	FEB 1
FEB 11	20	39.5	4.2	38.5	51.0 77	33.4 66	55 77	47.6	3.6	48.0	15 66	30.6	7.0	30.5	FEB 11
FEB 21	20	41.5	5.5	42.5	47.5 70	24.1 62	58 80	49.4	4.9	50.5	11 62	33.6	7.3	35.0	FEB 21
MAR 1	19	43.0	4.5	42.0	52.9 81	36.9 71	65 72	52.3	5.6	52.0	27 76	34.3	5.9	32.0	MAR 1
MAR 11	19	45.7	4.1	45.0	53.9 72	38.7 63	64 78	55.2	3.9	55.0	23 65	36.4	4.7	37.0	MAR 11
MAR 21	19	47.8	5.4	46.0	62.0 78	37.8 75	68 78	58.9	5.7	59.0	23 75	36.6	6.7	37.0	MAR 21
APR 1	18	51.3	4.9	50.5	59.7 69	41.4 75	76 77	61.0	7.4	60.0	34 63	41.2	5.4	40.5	APR 1
APR 11	18	55.1	6.3	54.0	65.7 62	43.0 70	78 80	65.6	7.7	65.0	35 63	43.2	4.7	43.0	APR 11
APR 21	18	58.1	7.7	58.5	73.8 77	45.4 70	81 77	69.2	8.7	70.0	36 67	46.3	8.2	44.5	APR 21
MAY 1	17	62.6	4.3	62.0	68.6 69	53.9 75	79 81	72.9	4.1	73.0	40 79	49.2	5.7	50.0	MAY 1
MAY 11	17	64.8	6.9	64.0	77.9 73	49.5 74	83 70	76.0	6.5	77.0	41 81	51.9	7.6	49.0	MAY 11
MAY 21	17	67.6	4.9	67.0	75.4 65	59.9 80	86 77	80.5	4.0	81.0	43 80	53.9	6.9	52.0	MAY 21
JUN 1	17	71.7	5.7	72.0	81.7 77	63.2 62	92 72	81.5	5.6	81.0	51 62	59.2	5.9	58.0	JUN 1
JUN 11	17	73.0	5.9	71.0	90.5 74	66.8 81 M	95 74	82.5	5.7	82.0	50 81	61.4	8.4	60.0	JUN 11
JUN 21	17	77.3	6.4	78.0	86.4 81 M	60.6 69	92 81	86.8	4.9	88.0	48 69	65.2	9.5	67.0	JUN 21
JUL 1	17	81.9	5.5	82.0	89.6 73	70.8 78	100 73	89.1	5.1	89.0	59 78	72.1	6.7	73.0	JUL 1
JUL 11	17	83.8	3.2	84.0	89.0 81	77.1 62	97 73	90.9	3.4	91.0	59 72	74.0	7.2	75.0	JUL 11
JUL 21	17	85.3	3.4	86.0	89.4 80	75.9 62	98 72	91.8	3.1	92.0	60 62	75.8	8.6	78.0	JUL 21
AUG 1	17	84.2	5.1	85.0	90.8 79	70.6 62	98 79	91.5	3.9	92.0	63 62	76.8	6.7	77.0	AUG 1
AUG 11	19	82.2	6.4	84.0	90.0 67	66.9 68	95 81	89.7	3.7	90.0	53 78	71.4	11.4	75.0	AUG 11
AUG 21	19	79.5	6.1	78.0	89.4 81 M	67.9 62	97 69	87.5	5.0	88.0	56 75	70.0	8.0	70.0	AUG 21
SEP 1	19	78.2	4.6	78.0	84.6 81	69.0 70	93 67	87.0	4.2	88.0	50 73	66.1	8.0	68.0	SEP 1
SEP 11	18	70.8	6.5	70.0	86.0 81	56.7 78	94 81	81.9	4.9	82.0	45 68	55.3	7.3	56.0	SEP 11
SEP 21	19	69.5	7.4	70.0	79.8 79	56.9 62	87 67	78.9	5.8	79.0	39 68	57.4	9.9	59.0	SEP 21
OCT 1	19	65.6	7.3	66.0	78.2 79	53.8 69	83 79	75.5	5.8	77.0	41 70	54.1	10.4	51.0	OCT 1
OCT 11	19	59.1	6.5	61.0	67.4 63	46.2 69	79 79	68.8	6.5	69.0	35 69	47.7	8.2	45.0	OCT 11
OCT 21	19	53.2	4.7	52.0	59.8 64 M	43.7 70	70 73	64.3	4.8	65.0	24 71	42.2	6.6	43.0	OCT 21
NOV 1	19	47.0	4.8	46.0	55.0 80	37.8 73	65 75	55.9	5.4	56.0	25 78	38.3	6.0	39.0	NOV 1
NOV 11	19	41.7	5.4	42.0	50.6 76	32.9 78	61 76	50.4	6.3	51.0	15 77	31.3	7.3	32.0	NOV 11
NOV 21	19	34.8	3.2	35.0	40.2 74	27.2 79	54 74	43.5	4.5	43.0	13 79	24.8	6.7	23.0	NOV 21
DEC 1	19	32.7	6.3	34.0	42.8 75	17.7 72	55 65	43.7	6.0	42.0	0 72	22.1	9.2	25.0	DEC 1
DEC 11	19	29.5	5.5	30.0	39.6 79	19.8 67	48 79	39.1	3.8	39.0	2 63	18.4	8.4	21.0	DEC 11
DEC 21	19	29.1	4.8	28.0	41.9 80 M	22.4 78	50 80	40.7	4.4	40.0	-8 78	16.8	9.0	19.0	DEC 21
MONTH															MONTH
JAN	20	29.4	4.3	29.5	36.0 67	17.9 79	57 71	44.8	4.7	45.0	-10 79	10.1	9.0	10.5	JAN
FEB	20	38.7	2.8	38.5	43.9 77	32.4 66	58 80	50.9	3.7	51.5	11 62	23.6	7.0	24.0	FEB
MAR	19	45.6	3.3	44.0	52.7 78	41.7 71	68 78	59.7	4.6	60.0	23 75	31.2	4.3	31.0	MAR
APR	18	54.9	4.8	54.5	64.1 77	45.8 75	81 77	71.0	7.0	71.0	34 63	38.3	3.0	38.0	APR
MAY	17	65.1	3.6	64.0	71.1 76	60.2 78	86 77	81.2	3.7	82.0	40 79	46.2	4.8	45.0	MAY
JUN	17	73.9	3.2	74.0	81.7 74	69.5 62 M	95 74	88.8	3.3	89.0	48 69	54.4	3.3	55.0	JUN
JUL	17	83.8	2.8	84.0	88.1 81	76.7 62	100 73	93.7	3.2	94.0	59 78	67.5	6.0	67.0	JUL
AUG	17	82.0	4.8	81.0	89.4 81 M	72.3 62	98 79	92.9	2.8	93.0	53 78	65.8	9.6	66.0	AUG
SEP	18	72.7	4.5	72.0	81.7 79	65.2 62	94 81	87.6	3.7	88.0	39 68	52.1	7.3	50.0	SEP
OCT	18	58.7	4.6	58.0	66.3 78	50.7 69	83 79	75.6	5.0	77.5	24 71	40.5	5.7	41.0	OCT
NOV	19	41.1	2.8	41.0	46.1 76	36.8 62 M	65 75	56.6	5.1	57.0	13 79	23.8	6.2	23.0	NOV
DEC	19	30.4	3.5	29.0	36.5 79	23.9 78	55 65	45.7	4.4	45.0	-8 78	13.0	9.0	15.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101932 COBALT — 1962-1981

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	20	3.4	9.5	5.0	15.4 66	-18.3 74	32 69	19.6	8.4	20.0	-28 79	-12.1	11.2	-1.0	JAN 1
JAN 11	20	10.2	8.1	12.0	21.7 67	-9.4 63	34 74	23.9	8.0	25.0	-29 63	-7.4	9.7	-1.0	JAN 11
JAN 21	20	6.4	8.4	4.0	20.2 74	-6.9 63	32 71	22.1	9.1	26.5	-30 62	-9.9	9.8	-1.0	JAN 21
FEB 1	20	9.8	5.4	9.0	18.6 78	-1.5 76	32 63	24.5	4.9	24.5	-24 72	-3.4	9.5	-1.0	FEB 1
FEB 11	20	14.0	4.4	14.0	21.2 81	6.3 64	33 70	26.9	4.8	27.5	-10 64	-0.8	5.5	-1.0	FEB 11
FEB 21	20	12.9	7.2	14.0	22.4 68	-2.6 62	31 78	23.9	5.3	24.0	-22 62	1.6	9.8	2.5	FEB 21
MAR 1	19	14.6	6.1	16.0	24.2 80	4.0 69	38 78	26.9	5.5	28.0	-11 71	1.7	8.8	-1.0	MAR 1
MAR 11	19	15.8	5.4	17.0	25.6 72	5.1 65 M	39 81	27.4	4.9	28.0	-8 69	4.3	8.3	3.0	MAR 11
MAR 21	19	19.9	4.4	20.0	28.3 81	10.9 64	40 81	29.8	4.3	30.0	-10 75	9.1	7.6	9.0	MAR 21
APR 1	18	22.6	2.8	22.5	28.3 78	15.9 75	35 77	30.6	2.9	31.0	2 75	13.1	5.2	13.5	APR 1
APR 11	18	24.0	2.8	24.5	27.6 80	17.3 64	40 81	31.7	3.7	32.0	5 64	15.7	4.4	17.0	APR 11
APR 21	18	27.6	3.5	26.5	35.5 80	22.0 63	44 80	34.3	4.2	34.0	12 68	21.2	4.8	19.5	APR 21
MAY 1	17	30.5	3.2	29.0	39.9 80	26.5 72	49 78	37.5	4.7	37.0	14 72	22.6	4.6	23.0	MAY 1
MAY 11	17	31.7	2.3	31.0	37.0 69	26.6 74	44 68	38.9	3.5	40.0	16 73	24.8	3.4	25.0	MAY 11
MAY 21	17	33.9	2.3	33.0	38.3 81 M	29.2 75	62 81	43.1	5.8	42.0	20 75	26.0	2.8	26.0	MAY 21
JUN 1	17	37.2	3.5	36.0	44.2 77	32.1 62	51 77	44.1	3.5	44.0	25 73	30.1	2.8	30.0	JUN 1
JUN 11	17	38.9	2.5	38.0	43.0 77	34.2 78	50 80	46.0	2.9	45.0	27 73	31.5	3.4	31.0	JUN 11
JUN 21	17	40.1	3.0	39.0	45.8 73	35.7 75	55 73	47.4	3.5	47.0	26 76	32.9	4.2	33.0	JUN 21
JUL 1	17	41.1	3.0	41.0	46.9 75	34.9 62	53 77	48.2	2.8	48.0	28 81	33.6	4.1	32.0	JUL 1
JUL 11	17	42.7	3.4	42.0	49.3 75	36.8 63	59 73	49.8	5.6	48.0	31 63	36.1	2.6	36.0	JUL 11
JUL 21	17	43.2	2.6	43.0	47.6 75	36.2 63	62 76	50.9	4.8	52.0	31 63	37.2	2.8	38.0	JUL 21
AUG 1	17	41.7	2.9	41.0	47.0 68	35.1 63	59 70	49.9	4.5	49.0	29 69	35.8	3.3	36.0	AUG 1
AUG 11	19	41.4	2.7	41.0	47.2 79	37.5 74	55 69	48.0	3.7	48.0	32 80	36.5	3.1	37.0	AUG 11
AUG 21	19	38.9	3.0	39.0	42.8 72	31.5 63	55 69	47.0	5.2	48.0	28 63	31.7	3.6	30.0	AUG 21
SEP 1	19	36.5	3.1	36.0	42.2 78	30.6 62	54 67	44.0	5.5	44.0	22 74	28.4	3.8	28.0	SEP 1
SEP 11	18	33.9	3.6	33.0	40.6 76	27.3 71	50 69	42.8	4.2	43.0	18 71	26.8	4.7	26.5	SEP 11
SEP 21	19	31.7	3.5	31.0	37.8 67	25.0 62	47 76	39.2	4.0	39.0	17 62	25.3	4.6	26.0	SEP 21
OCT 1	19	28.8	2.7	28.0	35.8 63	24.4 73	43 75	36.7	3.3	36.0	14 74	21.5	4.0	22.0	OCT 1
OCT 11	19	26.6	3.8	26.0	32.1 79	16.7 69	41 79	35.2	5.1	36.0	9 69	20.0	5.1	20.0	OCT 11
OCT 21	19	23.8	3.4	24.0	29.3 77	18.6 70	44 75	33.4	4.3	33.0	-8 71	15.7	7.1	17.0	OCT 21
NOV 1	19	22.3	3.7	22.0	29.6 80	11.8 71	40 80	31.9	4.3	32.0	-1 71	12.6	6.1	12.0	NOV 1
NOV 11	19	20.1	5.0	20.0	28.1 81	13.0 77	40 81	30.4	4.5	30.0	-10 77	9.2	7.0	9.0	NOV 11
NOV 21	19	13.7	4.3	14.0	19.4 71	2.7 79	32 77	25.9	4.9	27.0	-12 79	0.1	6.6	1.0	NOV 21
DEC 1	18	12.3	7.7	13.5	23.7 75	-6.6 72	33 72	25.1	6.7	26.0	-25 72	-1.3	10.8	2.5	DEC 1
DEC 11	18	10.0	6.9	9.5	19.2 69	-2.0 67	31 79	23.1	6.1	22.5	-19 72	-3.7	8.1	-1.0	DEC 11
DEC 21	18	7.7	5.3	5.5	18.4 67	-2.3 78	30 72	22.9	4.4	22.0	-34 78	-8.4	9.8	-1.0	DEC 21
MONTH															MONTH
JAN	20	6.6	5.8	6.0	16.5 67	-5.0 79	34 74	27.4	5.2	28.5	-30 62	-17.9	9.4	-1.0	JAN
FEB	20	12.2	3.6	11.5	17.6 78	5.0 64	33 70	28.0	4.4	29.5	-24 72	-8.2	8.0	-1.0	FEB
MAR	19	16.9	4.5	17.0	23.7 81	7.7 64	40 81	30.8	4.5	31.0	-11 71	-0.9	8.0	-1.0	MAR
APR	18	24.8	2.5	24.5	29.5 78	20.1 64	44 80	35.1	4.1	35.0	2 75	12.2	5.0	12.5	APR
MAY	17	32.1	1.6	31.0	36.5 80	29.4 74	62 81	44.2	5.6	43.0	14 72	21.2	3.6	22.0	MAY
JUN	17	38.7	1.9	38.0	43.0 77	35.7 62 M	55 73	48.8	3.0	49.0	25 73	28.5	2.5	28.0	JUN
JUL	17	42.4	2.5	43.0	47.9 75	37.4 63	62 76	53.1	4.4	53.0	28 81	32.9	3.2	32.0	JUL
AUG	17	40.8	2.2	41.0	43.9 79	35.0 63	59 70	51.8	3.7	51.0	28 63	31.4	3.0	30.0	AUG
SEP	18	34.0	2.6	34.0	37.6 67	29.2 62	54 67	46.1	4.6	45.5	17 62	23.0	3.2	23.5	SEP
OCT	18	26.3	1.9	25.5	29.5 79	23.5 69	44 75	39.2	2.7	40.0	-8 71	13.2	6.3	15.0	OCT
NOV	19	18.7	2.4	18.0	22.4 81	12.7 79	40 81	33.2	4.2	32.0	-12 79	-1.2	5.8	0.0	NOV
DEC	18	9.9	4.4	9.5	16.4 73 M	3.3 78	33 72	27.6	3.9	28.5	-34 78	-11.5	9.5	-1.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 102575 DIXIE 1952-1980

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
JAN 1	28	27.7	6.4	27.5	37.0 53	12.2 74	48 54	36.7	7.2	36.5	1 79	17.3	7.4	17.0	JAN 1
JAN 11	28	31.2	4.7	32.0	41.5 61	20.5 63	48 73	39.4	5.5	40.5	5 63	21.7	6.7	22.5	JAN 11
JAN 21	28	30.7	5.0	31.0	38.2 61	20.2 57	49 62	39.9	5.1	40.0	4 62	20.6	6.9	23.0	JAN 21
FEB 1	28	35.0	5.9	35.0	48.8 54	26.8 72	56 63	42.7	6.0	42.0	10 76	26.0	7.8	25.5	FEB 1
FEB 11	28	35.3	4.7	34.5	46.3 77	25.5 56	54 77	43.4	5.7	43.0	15 56	27.9	5.7	28.0	FEB 11
FEB 21	28	36.4	6.4	35.0	46.0 70	20.0 62	57 77	44.5	7.5	43.5	11 62	28.5	6.8	29.0	FEB 21
MAR 1	28	35.9	4.8	35.0	48.9 68	28.6 71	57 68	45.1	5.5	44.5	16 55	26.6	5.6	27.0	MAR 1
MAR 11	28	38.5	3.9	38.5	47.3 79	30.2 55	64 60	48.2	5.7	48.0	19 65	29.5	4.7	30.0	MAR 11
MAR 21	28	41.7	5.8	40.5	53.6 78	30.5 75	62 78	52.1	6.1	52.0	18 75	31.4	5.5	33.0	MAR 21
APR 1	28	44.0	4.8	43.0	57.1 60	31.9 75	66 77	53.9	6.3	53.0	26 75	34.2	3.8	34.0	APR 1
APR 11	28	45.8	5.2	44.5	60.6 62	36.8 72	71 62	56.4	6.4	56.5	29 76	36.6	4.5	36.5	APR 11
APR 21	28	48.3	5.3	48.0	63.9 77	38.2 70	75 77	59.5	7.5	58.5	32 76	37.1	3.7	36.0	APR 21
MAY 1	28	53.3	6.1	52.0	69.9 66	41.4 75	81 66	65.5	6.9	64.5	32 75	41.0	6.3	39.0	MAY 1
MAY 11	28	57.3	6.5	56.5	70.6 54	41.6 74	81 58	69.8	7.3	71.0	36 74	43.4	5.0	43.5	MAY 11
MAY 21	28	59.5	6.2	58.0	74.5 58	50.1 75	84 58	72.4	5.7	73.0	36 80	45.0	6.0	44.0	MAY 21
JUN 1	28	64.1	6.2	62.0	74.6 70	54.7 54	88 77	74.6	6.3	75.0	42 80	51.9	6.9	50.5	JUN 1
JUN 11	28	65.[illegible]	6.5	65.0	82.4 74	56.5 76	87 74	76.8	5.2	77.0	41 76	53.1	8.5	51.5	JUN 11
JUN 21	28	68.6	5.7	67.5	78.4 61	54.3 69	88 55	79.9	5.0	80.0	40 70	53.4	8.0	52.5	JUN 21
JUL 1	29	73.8	5.2	74.0	83.9 75	60.8 55	89 74	82.9	4.6	84.0	50 55	61.4	6.9	60.0	JUL 1
JUL 11	29	77.2	4.6	76.0	89.0 60	68.4 80	96 60	85.8	4.3	86.0	50 72	66.1	7.5	65.0	JUL 11
JUL 21	29	79.7	2.9	80.0	85.9 60	74.6 63	94 59	87.4	3.0	87.0	57 72	69.3	6.9	69.0	JUL 21
AUG 1	28	78.8	4.2	78.0	88.5 61	70.0 76	99 61	86.6	4.2	87.5	55 76	68.4	6.7	68.5	AUG 1
AUG 11	28	76.9	6.3	78.0	88.0 67	63.0 68	94 61	85.2	4.3	86.5	45 78	66.2	10.6	68.5	AUG 11
AUG 21	28	72.7	6.4	72.0	84.4 70	61.2 60	94 69	83.0	5.9	83.5	44 60	59.6	8.6	61.0	AUG 21
SEP 1	29	70.8	5.4	70.0	84.3 55	61.6 70	93 55	81.6	4.4	81.0	44 70	56.4	7.6	55.0	SEP 1
SEP 11	29	65.4	6.5	65.0	79.2 53	49.9 78	88 53	77.9	6.3	80.0	38 70	51.2	7.2	52.0	SEP 11
SEP 21	29	63.5	8.7	62.0	78.7 52	49.2 59	84 66	74.6	6.4	75.0	35 68	50.4	10.0	47.0	SEP 21
OCT 1	29	60.5	7.2	60.0	74.9 52	46.8 69	79 52	72.4	5.0	73.0	36 77	46.8	9.8	44.0	OCT 1
OCT 11	29	55.8	6.1	57.0	64.4 74	40.4 69	75 79	67.5	6.3	69.0	31 69	43.1	6.5	42.0	OCT 11
OCT 21	29	49.0	6.6	49.0	62.3 62	37.5 71	69 52	60.5	5.5	62.0	20 71	36.8	6.8	36.0	OCT 21
NOV 1	28	44.4	5.2	44.0	55.8 54	32.9 73	64 65	54.4	5.6	56.0	20 78	34.8	6.5	35.5	NOV 1
NOV 11	28	38.0	5.6	37.0	47.2 76	22.7 55	62 54	47.6	6.3	49.0	3 55	27.9	7.8	29.0	NOV 11
NOV 21	28	35.4	4.5	35.0	45.1 56	27.3 75	58 54	44.0	5.7	43.5	11 75	26.3	6.4	27.5	NOV 21
DEC 1	29	33.1	5.2	33.0	43.9 65	17.8 72	51 59	42.7	4.3	43.0	5 72	23.6	7.2	25.0	DEC 1
DEC 11	29	32.3	5.3	34.0	39.8 62	21.4 67	48 79	40.7	4.6	41.0	3 64	23.9	8.1	25.0	DEC 11
DEC 21	29	31.0	3.9	31.0	39.7 80	21.1 78	48 54	39.8	4.0	40.0	1 78	21.5	6.7	23.0	DEC 21
MONTH															MONTH
JAN	28	29.9	3.4	29.5	38.2 61	21.9 79	49 62	43.0	3.8	43.0	1 79	14.4	6.7	15.0	JAN
FEB	28	35.5	4.2	34.0	44.1 65	29.5 56	57 77	48.2	5.5	47.0	10 76	22.5	6.3	24.0	FEB
MAR	28	38.8	3.5	39.0	44.8 68	32.3 55	64 60	53.4	5.3	52.5	16 55	24.7	4.6	26.5	MAR
APR	28	46.0	3.6	45.0	52.9 77	38.0 75	75 77	61.7	6.1	61.0	26 75	33.0	2.7	33.0	APR
MAY	28	56.0	4.5	55.5	68.8 58	48.9 75	84 58	74.4	5.1	75.0	32 75	38.1	3.7	37.5	MAY
JUN	28	66.2	3.5	65.5	76.3 61	60.9 76	88 77	82.2	3.6	82.0	40 70	47.0	5.8	45.5	JUN
JUL	29	77.0	2.8	77.0	84.9 60	72.0 77	96 60	88.6	2.9	89.0	50 72	59.4	6.1	58.0	JUL
AUG	28	76.0	4.6	75.5	84.1 61	69.0 75	99 61	88.4	3.3	89.0	44 60	58.0	8.0	59.5	AUG
SEP	29	66.6	5.4	67.0	75.2 67	57.2 65	93 55	82.3	4.1	82.0	35 68	46.0	6.4	46.0	SEP
OCT	29	54.9	4.5	54.0	66.6 52	45.7 69	79 52	73.2	3.5	74.0	20 71	35.2	4.9	36.0	OCT
NOV	28	39.3	3.7	39.0	48.5 54	32.2 55	64 65	55.1	4.8	56.0	3 55	23.2	6.7	25.0	NOV
DEC	29	32.1	3.5	33.0	36.6 62	23.5 78	51 59	44.3	4.0	45.0	1 78	17.8	7.4	20.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 102575 DIXIE

1952-1980

		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	28	1.3	10.4	2.5	17.5 53	-27.8 74	35 53	20.5	11.0	23.5	-42 79	-18.9	11.6	-1.0	JAN 1
JAN 11	28	8.5	8.2	8.0	27.8 53	-9.5 60	34 74	26.4	5.5	27.5	-42 63	-13.8	11.8	-1.0	JAN 11
JAN 21	28	3.6	9.4	3.0	20.9 53	-14.2 57	33 71	22.5	8.1	24.0	-40 56	-17.6	12.5	-1.0	JAN 21
FEB 1	28	6.4	8.0	6.0	22.7 61	-10.3 76	36 61	23.0	6.8	23.5	-39 56	-11.3	12.3	-1.0	FEB 1
FEB 11	28	10.1	6.2	9.5	21.4 61	-4.8 55	34 61	25.3	5.4	25.5	-42 56	-8.1	11.3	-1.0	FEB 11
FEB 21	28	7.8	8.8	9.0	23.0 57	-8.8 60	33 63	22.6	6.7	23.0	-38 62	-6.0	12.4	-1.0	FEB 21
MAR 1	28	8.2	5.9	8.5	18.8 80	-3.5 76	32 79	24.1	5.6	24.0	-36 55	-9.6	10.2	-1.0	MAR 1
MAR 11	28	9.1	6.0	9.5	24.2 72	-3.0 65	30 74	23.0	5.3	23.0	-24 65	-7.6	8.8	-1.0	MAR 11
MAR 21	28	14.1	6.0	15.5	23.8 78	2.7 75	32 62	26.8	4.0	27.0	-23 75	-2.0	10.9	0.0	MAR 21
APR 1	28	18.4	4.3	18.5	26.7 69	8.1 75	33 72	28.6	4.2	30.0	-9 75	6.3	7.7	6.0	APR 1
APR 11	28	19.5	3.3	20.0	25.5 58	11.5 64	33 66	29.3	2.7	30.0	-4 72	7.2	5.3	8.5	APR 11
APR 21	28	23.2	2.6	23.0	29.0 80	18.6 72	35 80	30.5	2.2	30.0	7 68	14.3	4.5	13.5	APR 21
MAY 1	28	25.9	3.3	25.0	32.7 80	19.1 65	42 54	32.9	3.6	32.0	4 72	17.2	6.5	19.0	MAY 1
MAY 11	28	27.5	2.9	27.0	34.6 57	21.5 74	44 78	34.3	3.7	33.5	8 74	20.9	4.4	21.0	MAY 11
MAY 21	28	29.9	2.6	29.0	36.1 58	25.1 54	45 63	38.4	3.5	38.5	14 66	22.7	4.3	23.0	MAY 21
JUN 1	28	33.2	3.5	32.0	39.9 77	26.8 65	50 77	40.8	4.2	41.0	20 55	25.8	3.1	26.0	JUN 1
JUN 11	28	34.7	2.1	34.0	39.6 63	31.3 79	49 68	42.6	3.1	43.0	21 54	27.8	2.9	28.0	JUN 11
JUN 21	28	35.0	2.8	34.5	41.8 70	31.2 76	51 70	43.6	3.9	43.5	20 76	27.4	3.2	27.0	JUN 21
JUL 1	29	35.7	2.9	35.0	43.4 75	30.9 62	53 70	44.0	4.4	44.0	23 71	28.2	3.1	28.0	JUL 1
JUL 11	29	37.5	3.1	36.0	45.6 75	32.5 62	56 75	46.0	4.8	46.0	25 62	30.6	3.3	31.0	JUL 11
JUL 21	29	36.6	2.9	36.0	41.0 55	30.4 63	53 60	46.1	4.7	45.0	24 59	29.9	3.0	30.0	JUL 21
AUG 1	28	35.7	2.8	36.0	41.8 71	29.8 54	54 76	44.7	4.9	45.5	25 69	29.3	2.4	29.0	AUG 1
AUG 11	28	35.0	2.4	34.0	39.9 72	31.3 57	49 68	43.6	3.8	44.0	23 66	28.5	2.6	28.0	AUG 11
AUG 21	28	32.7	2.5	32.0	37.6 61	28.3 55	49 66	42.2	4.2	43.0	19 65	25.9	3.3	25.5	AUG 21
SEP 1	29	30.5	3.0	30.0	37.6 78	24.7 62	52 63	39.0	4.8	37.0	17 62	23.2	3.2	24.0	SEP 1
SEP 11	29	29.1	4.2	28.0	37.8 59	20.1 71	48 59	38.2	5.3	37.0	9 65	21.7	5.0	22.0	SEP 11
SEP 21	29	26.7	2.6	27.0	31.1 66	22.3 74	43 76	34.2	4.1	34.0	14 71	20.3	4.0	20.0	SEP 21
OCT 1	29	24.2	3.1	24.0	31.4 63	17.5 73	40 55	32.3	4.4	32.0	10 54	17.6	4.0	18.0	OCT 1
OCT 11	29	22.9	3.9	23.0	27.8 62	12.8 69	41 63	31.9	4.7	32.0	5 69	16.0	4.4	16.0	OCT 11
OCT 21	29	20.5	3.7	20.0	27.8 57	12.0 71	40 59	29.4	4.2	29.0	-13 71	11.2	7.0	13.0	OCT 21
NOV 1	28	17.1	5.4	18.0	26.7 58	2.6 71	34 76	28.3	3.5	29.0	-17 71	5.3	9.0	7.0	NOV 1
NOV 11	28	15.2	8.0	17.5	26.0 54	-0.7 55	36 66	28.0	5.0	28.5	-35 55	-0.5	13.7	1.5	NOV 11
NOV 21	28	9.7	6.8	11.5	21.6 53	-6.5 79	36 60	24.5	7.4	26.0	-22 79	-7.8	9.0	-1.0	NOV 21
DEC 1	29	7.9	7.7	7.0	20.2 79	-18.6 72	33 58	24.4	4.7	24.0	-39 72	-10.7	11.4	-1.0	DEC 1
DEC 11	29	6.3	8.1	6.0	19.7 69	-8.4 67	32 77	23.6	6.5	25.0	-48 64	-14.1	12.8	-1.0	DEC 11
DEC 21	29	6.3	7.1	5.0	26.2 80	-8.9 78	36 55	23.9	5.7	23.0	-43 78	-12.4	10.8	-1.0	DEC 21
MONTH															MONTH
JAN	28	4.4	6.4	4.0	22.0 53	-10.5 79	35 53	29.0	4.0	30.0	-42 79	-27.7	9.5	-1.0	JAN
FEB	28	8.2	4.6	7.5	19.5 61	-0.1 55	36 61	28.4	4.3	30.5	-42 56	-17.6	11.0	-1.0	FEB
MAR	28	10.6	3.9	10.0	16.4 78	1.0 65	32 79	28.9	3.1	30.0	-36 55	-14.1	7.6	-1.0	MAR
APR	28	20.4	2.2	20.0	24.4 69	15.6 70	35 80	31.8	1.6	32.0	-9 75	3.4	5.9	5.0	APR
MAY	28	27.8	2.2	27.0	31.8 80	24.2 65	45 63	39.4	3.1	39.0	4 72	15.5	6.1	16.0	MAY
JUN	28	34.3	2.0	34.0	37.9 58	30.4 65	51 70	45.4	3.3	45.0	20 76	24.6	2.5	25.0	JUN
JUL	29	36.6	2.1	36.0	42.9 75	33.5 62	56 75	49.3	3.5	49.0	23 71	27.2	2.4	27.0	JUL
AUG	28	34.4	1.8	33.5	37.5 58	31.1 80	54 76	47.1	2.9	47.0	19 65	25.3	2.8	25.0	AUG
SEP	29	28.7	2.3	27.0	33.1 80	24.3 71	52 63	41.1	4.7	40.0	9 65	18.1	3.7	17.0	SEP
OCT	29	22.5	2.3	22.0	26.6 63	17.8 78	41 63	34.4	3.9	34.0	-13 71	9.4	6.0	10.0	OCT
NOV	28	14.0	4.1	14.5	20.3 53	7.0 56	36 66	31.2	2.8	31.0	-35 55	-12.5	9.0	-1.0	NOV
DEC	29	6.8	4.5	6.0	15.1 58	-4.0 78	36 55	28.2	4.2	29.0	-48 64	-21.0	10.9	-1.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 105708 MC CALL

1951-1980

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	30	27.8	5.2	28.0	35.8 63	16.4 79	46 54	35.7	5.7	36.0	1 79	18.8	5.9	20.0	JAN 1
JAN 11	30	31.2	5.0	32.0	38.8 61	19.8 63	48 73	37.4	5.5	38.0	6 63	23.0	6.1	24.0	JAN 11
JAN 21	30	30.2	4.5	31.0	37.5 76	18.7 57	49 71	38.4	5.1	39.0	4 51	20.9	6.4	21.5	JAN 21
FEB 1	30	34.7	4.7	34.0	50.0 63	27.3 56	56 63	41.1	4.9	40.5	10 56	27.4	7.2	29.0	FEB 1
FEB 11	30	35.1	5.1	35.0	48.4 77	22.5 56	54 63	42.9	4.9	42.0	4 56	28.6	7.4	29.5	FEB 11
FEB 21	30	36.3	6.3	35.5	47.9 68	22.1 62	54 80	42.5	6.7	42.0	13 62	29.8	7.3	32.0	FEB 21
MAR 1	30	36.9	5.2	36.0	46.7 68	25.2 51	62 72	44.4	6.2	44.5	18 55	28.9	5.9	30.0	MAR 1
MAR 11	30	39.2	4.5	38.5	50.1 72	30.3 55	61 72	47.2	5.8	46.0	22 56	31.4	4.9	32.0	MAR 11
MAR 21	30	42.8	5.3	42.0	58.4 78	34.5 55	64 78	51.3	6.5	50.0	22 75	33.5	4.7	33.0	MAR 21
APR 1	30	46.7	5.3	46.0	57.2 66	37.0 53	70 77	55.2	6.7	56.0	30 55	37.6	3.7	38.0	APR 1
APR 11	30	48.6	5.7	48.0	63.5 62	36.0 55	70 62	57.8	7.0	57.5	30 60	39.3	5.2	39.5	APR 11
APR 21	30	51.8	7.4	51.0	73.1 77	39.9 55	80 77	61.8	8.0	62.0	30 51	40.4	7.5	38.0	APR 21
MAY 1	30	56.9	6.5	57.0	75.1 66	42.2 59	83 66	67.1	6.7	67.0	32 75	44.3	7.4	42.5	MAY 1
MAY 11	30	60.5	6.5	59.5	76.2 73	46.8 74	83 58	71.5	7.2	72.5	32 55	47.4	7.3	46.0	MAY 11
MAY 21	30	63.0	6.3	62.5	76.9 58	51.3 53	85 66	74.2	5.8	74.0	38 80	50.0	6.7	50.0	MAY 21
JUN 1	30	67.4	6.7	66.0	79.4 77	54.0 54	90 77	76.2	6.0	76.0	40 54	56.6	7.6	55.5	JUN 1
JUN 11	30	69.5	6.6	69.0	87.8 74	55.5 54	93 77	79.4	6.4	79.5	42 54	57.3	8.1	56.0	JUN 11
JUN 21	30	72.5	5.9	71.5	83.7 61	60.5 69	89 55	81.9	5.6	82.0	50 69	60.8	6.4	60.0	JUN 21
JUL 1	30	77.5	5.1	77.0	87.6 68	61.0 55	96 73	85.2	5.2	85.5	48 55	66.5	6.8	67.5	JUL 1
JUL 11	30	81.5	3.6	80.5	89.1 60	74.2 80	96 70	88.2	4.1	88.0	57 74	72.7	5.8	72.0	JUL 11
JUL 21	30	83.7	2.7	83.0	88.0 68	78.0 63	94 68	89.3	2.5	89.0	65 75	75.9	5.2	76.0	JUL 21
AUG 1	30	82.0	4.5	82.5	89.1 71	72.4 56	98 61	88.0	4.2	88.5	60 56	74.6	6.8	76.0	AUG 1
AUG 11	30	80.4	5.8	81.0	92.1 67	68.0 68	95 67	87.5	3.2	88.0	49 68	70.8	10.0	74.0	AUG 11
AUG 21	30	75.3	6.3	74.0	88.1 67	65.7 60	96 69	84.7	5.9	85.0	47 60	64.0	8.8	63.0	AUG 21
SEP 1	30	74.2	4.6	75.0	83.8 55	63.5 64	91 55	82.8	4.1	83.0	48 64	62.6	6.4	63.0	SEP 1
SEP 11	30	68.6	5.7	67.5	77.9 79	55.4 78	86 53	79.6	5.3	81.0	43 65	54.8	6.0	54.5	SEP 11
SEP 21	30	66.4	7.7	65.5	79.4 67	52.7 59	86 66	75.6	6.8	76.0	37 68	55.1	9.1	55.5	SEP 21
OCT 1	30	62.9	6.6	62.5	76.2 79	48.7 57	81 79	73.3	5.1	74.0	36 57	50.4	8.8	48.5	OCT 1
OCT 11	30	58.1	6.0	58.5	68.5 58	45.2 51	77 71	67.9	6.2	69.0	38 71	46.8	6.5	45.0	OCT 11
OCT 21	30	51.2	7.0	51.5	65.0 62	37.2 56	70 52	61.4	5.7	62.0	27 71	41.1	7.9	41.5	OCT 21
NOV 1	30	47.0	5.1	45.0	57.3 76	37.1 73	66 62	55.2	5.7	54.0	28 56	37.1	5.7	37.0	NOV 1
NOV 11	30	39.2	5.6	38.0	49.5 76	22.5 55	56 76	47.7	5.9	48.5	2 55	30.8	7.8	31.0	NOV 11
NOV 21	30	36.2	3.8	35.0	44.6 69	29.0 52	60 66	44.4	6.1	43.5	20 79	28.1	4.4	28.0	NOV 21
DEC 1	30	33.1	5.2	33.5	42.4 65	20.5 72	50 65	40.8	5.1	40.0	5 72	24.7	7.4	28.0	DEC 1
DEC 11	30	31.7	4.4	32.0	39.6 69	22.5 61	48 79	38.7	5.0	39.5	6 64	23.8	6.7	25.0	DEC 11
DEC 21	30	30.4	3.4	30.0	39.5 80	23.1 78	47 64	38.4	3.8	38.0	5 78	21.6	5.9	23.5	DEC 21
MONTH															MONTH
JAN	30	29.8	3.2	30.0	34.0 53	22.8 79	49 71	41.6	3.7	41.5	1 79	15.8	6.3	17.0	JAN
FEB	30	35.3	4.3	35.0	45.6 63	26.3 56	56 63	45.4	5.3	44.5	4 56	23.4	7.1	22.5	FEB
MAR	30	39.8	3.9	39.0	49.3 78	32.0 55	64 78	52.2	5.9	50.5	18 55	27.6	5.0	28.5	MAR
APR	30	49.0	4.6	49.0	61.2 77	39.3 55	80 77	63.1	6.9	62.5	30 60	35.0	2.8	35.5	APR
MAY	30	60.2	4.6	60.0	69.4 58	50.0 59	85 66	75.9	5.4	78.0	32 75	41.3	5.5	41.0	MAY
JUN	30	69.8	4.0	69.0	79.3 61	61.9 54	93 77	84.5	4.2	85.0	40 54	52.2	4.9	51.5	JUN
JUL	30	80.9	2.6	80.0	86.0 60	74.5 55	96 73	90.7	2.9	91.0	48 55	65.4	6.1	66.0	JUL
AUG	30	79.1	4.4	77.5	88.2 67	72.5 76	98 61	89.7	3.3	89.0	47 60	62.3	8.6	61.0	AUG
SEP	30	69.7	4.7	70.0	78.5 67	60.6 59	91 55	83.6	3.4	84.0	37 68	51.1	6.4	50.0	SEP
OCT	30	57.2	4.3	57.0	65.3 52	48.5 51	81 79	74.0	3.8	74.0	27 71	39.3	5.9	39.0	OCT
NOV	30	40.8	3.7	40.0	49.4 76	31.5 55	66 62	55.6	5.6	54.0	2 55	25.9	5.7	27.0	NOV
DEC	30	31.7	3.2	31.5	36.2 62	25.0 78	50 65	42.7	4.3	42.5	5 78	18.1	6.5	20.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 105708 MC CALL 1951-1980

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG.YR	LOWEST AVG.YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	30	10.1	8.3	10.5	23.0 53	-9.7 74	38 53	25.0	8.2	27.0	-26 79	-7.1	9.9	-1.0	JAN 1
JAN 11	30	15.9	7.9	16.5	29.0 53	-3.0 60	37 74	28.9	6.1	31.0	-22 60	-2.2	11.0	-1.0	JAN 11
JAN 21	30	10.9	8.2	10.0	23.8 53	-6.1 57	34 67	26.9	5.8	28.5	-31 62	-7.8	11.9	-1.0	JAN 21
FEB 1	30	13.5	7.8	12.5	29.9 61	-4.1 56	34 63	26.4	5.9	28.5	-29 56	-2.5	10.9	-1.0	FEB 1
FEB 11	30	15.6	6.7	13.5	27.8 61	2.4 55	34 58	28.6	4.0	30.0	-25 56	-0.3	11.0	0.5	FEB 11
FEB 21	30	13.9	8.4	16.0	24.2 72	-3.7 60	37 72	26.7	6.3	28.0	-22 62	0.9	10.8	1.5	FEB 21
MAR 1	30	14.4	6.1	14.5	25.0 57	1.5 76	37 72	27.6	5.7	30.0	-22 55	-0.2	9.2	-1.0	MAR 1
MAR 11	30	15.5	5.7	14.5	29.8 72	4.0 56	36 74	28.1	3.8	28.0	-16 51	1.3	8.2	2.0	MAR 11
MAR 21	30	20.2	4.8	20.0	29.2 78	11.5 75	34 73	30.2	2.7	30.5	-10 52	8.0	8.6	8.5	MAR 21
APR 1	30	23.5	3.7	24.0	28.3 72	12.5 75	37 78	31.4	2.9	32.0	-2 75	14.2	6.1	15.0	APR 1
APR 11	30	25.0	2.9	25.0	30.3 58	19.6 55	36 65	31.8	2.8	32.0	10 55	17.4	3.8	18.0	APR 11
APR 21	30	28.2	2.7	28.0	34.6 80	24.5 67	41 78	34.3	3.0	34.5	13 55	21.7	4.1	22.0	APR 21
MAY 1	30	31.5	2.9	31.0	38.3 80	26.2 55	46 80	38.8	3.1	38.0	15 72	24.7	4.5	26.0	MAY 1
MAY 11	30	33.3	2.6	33.0	38.2 69	26.3 74	48 78	40.8	3.7	40.5	15 74	26.6	4.0	27.0	MAY 11
MAY 21	30	36.0	3.5	35.0	45.3 58	30.1 75	58 77	44.4	4.8	44.0	18 75	28.4	4.6	28.0	MAY 21
JUN 1	30	39.2	3.8	38.5	45.7 72	32.9 54	59 77	46.8	4.2	48.0	25 54	31.8	4.3	31.5	JUN 1
JUN 11	30	40.9	3.4	40.0	47.6 63	35.1 78	55 74	48.3	3.4	48.0	27 52	34.1	4.6	33.5	JUN 11
JUN 21	30	40.9	3.3	40.0	47.2 73	34.4 76	56 59	49.3	3.6	49.0	24 76	32.7	3.8	32.0	JUN 21
JUL 1	30	43.0	3.0	43.0	48.6 61	37.9 73	58 68	50.8	4.2	51.0	26 55	35.2	4.4	35.0	JUL 1
JUL 11	30	45.4	3.0	46.0	51.0 55	40.3 66	63 73	53.4	4.3	53.0	32 74	38.6	3.5	38.0	JUL 11
JUL 21	30	45.3	3.2	45.0	51.5 60	40.5 66	62 59	53.7	3.8	54.0	30 54	37.8	4.2	37.0	JUL 21
AUG 1	30	44.0	3.4	43.0	51.0 61	36.7 75	60 71	52.6	4.6	52.5	29 69	37.2	4.1	37.0	AUG 1
AUG 11	30	43.0	3.6	42.0	50.2 58	35.7 74	65 61	50.8	5.8	49.0	29 78	36.3	4.3	36.5	AUG 11
AUG 21	30	39.8	3.0	39.0	49.6 61	35.4 80	56 61	48.6	4.4	48.0	25 56	31.8	4.2	30.5	AUG 21
SEP 1	30	37.9	3.2	37.5	47.3 63	29.9 75	61 63	46.4	5.0	47.0	23 75	29.8	3.1	30.0	SEP 1
SEP 11	30	36.2	4.3	36.0	44.0 59	27.1 71	54 59	44.3	5.1	44.5	19 71	28.1	4.6	28.5	SEP 11
SEP 21	30	33.6	4.0	33.0	41.0 66	25.7 75	50 63	41.8	5.3	41.5	18 54	26.3	4.4	26.5	SEP 21
OCT 1	30	30.9	3.8	31.0	42.5 63	21.8 74	48 55	40.6	4.7	41.0	12 74	23.4	4.6	24.0	OCT 1
OCT 11	30	29.8	3.7	30.0	35.2 53	22.8 74	52 53	39.0	5.3	40.0	14 76	23.1	3.9	24.0	OCT 11
OCT 21	30	26.7	3.0	26.5	31.9 59	20.7 78	46 63	35.9	4.9	35.5	6 71	18.4	5.3	19.0	OCT 21
NOV 1	30	25.3	4.0	25.0	33.6 58	15.9 71	42 80	34.2	4.4	34.0	4 56	16.0	6.0	17.0	NOV 1
NOV 11	30	22.8	6.3	23.5	33.0 67	8.2 55	38 73	33.1	3.9	33.0	-14 55	10.9	9.0	12.0	NOV 11
NOV 21	30	19.5	5.7	20.5	30.2 53	3.8 52	37 74	29.9	5.1	32.0	-6 79	7.3	7.5	8.0	NOV 21
DEC 1	30	17.4	5.7	17.0	27.2 75	0.1 72	35 75	29.1	3.8	30.0	-23 72	4.0	9.3	6.0	DEC 1
DEC 11	30	16.4	6.5	16.0	28.3 69	3.4 67	36 62	28.1	5.0	30.0	-24 64	1.8	9.4	3.0	DEC 11
DEC 21	30	14.5	6.2	13.0	29.6 80	-0.4 78	39 64	28.3	4.6	28.0	-26 78	-1.5	8.9	-1.0	DEC 21
MONTH															MONTH
JAN	30	12.2	5.6	12.0	25.2 53	-0.9 79	38 53	31.5	2.9	32.0	-31 62	-14.5	9.2	-1.0	JAN
FEB	30	14.4	5.2	13.0	26.0 61	5.6 64	37 72	30.9	2.9	31.5	-29 56	-8.2	9.9	-1.0	FEB
MAR	30	16.8	4.2	17.0	23.2 78	7.5 55	37 72	31.4	2.7	32.0	-22 55	-3.8	7.8	-1.0	MAR
APR	30	25.6	2.4	25.0	29.8 78	20.0 75	41 78	34.9	2.5	35.0	-2 75	13.3	5.5	15.0	APR
MAY	30	33.7	2.1	33.0	38.3 63	29.0 55	58 77	45.2	4.2	44.5	15 74	22.9	4.3	23.0	MAY
JUN	30	40.3	2.4	40.0	45.2 58	35.4 75	59 77	51.0	3.5	50.5	24 76	29.3	2.9	29.0	JUN
JUL	30	44.6	2.1	44.0	49.2 60	40.3 69	63 73	56.2	3.3	57.0	26 55	33.8	3.2	34.5	JUL
AUG	30	42.2	2.7	41.0	50.0 61	38.0 74	65 61	55.1	3.7	55.0	25 56	31.4	3.9	30.0	AUG
SEP	30	35.9	2.9	36.0	43.2 63	29.7 75	61 63	48.3	4.1	48.0	18 54	24.7	3.6	24.0	SEP
OCT	30	29.1	2.5	29.0	35.3 63	24.1 78	52 53	42.4	4.4	42.0	6 71	17.2	5.0	18.0	OCT
NOV	30	22.5	3.4	23.0	27.9 53	15.2 52	42 80	35.8	3.3	36.5	-14 55	3.6	6.4	4.0	NOV
DEC	30	16.0	4.0	15.0	24.3 58	5.9 78	39 64	31.9	2.7	32.0	-26 78	-6.4	8.4	-1.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 105897 MIDDLE FORK LODGE 1971-1981

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG, YR	LOWEST AVG, YR	HIGH, YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW, YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	10	27.1	9.2	30.5	37.6 81	11.6 79	58 78	36.7	9.8	36.5	0 79	15.8	9.7	15.5	JAN 1
JAN 11	10	36.5	2.4	36.5	38.7 76	30.3 79	54 76	46.0	4.6	44.5	17 73	25.0	5.7	25.0	JAN 11
JAN 21	10	33.9	4.5	34.5	38.6 81	26.5 79	49 81	44.2	3.3	44.0	11 80	23.6	8.3	26.5	JAN 21
FEB 1	9	37.0	3.7	37.0	42.3 78	32.5 76	54 78	46.6	3.4	46.0	13 79	25.3	9.8	27.0	FEB 1
FEB 11	9	43.1	4.7	42.0	54.4 77	38.6 75	59 77	51.6	4.3	51.0	27 81	35.7	6.1	35.0	FEB 11
FEB 21	9	43.9	3.2	43.0	48.1 81	39.1 75	64 77	52.7	4.7	51.0	28 75	37.1	4.6	38.0	FEB 21
MAR 1	10	46.6	4.8	46.0	56.5 81	39.3 76	70 72	55.3	6.6	54.0	26 76	37.4	7.6	34.0	MAR 1
MAR 11	10	49.6	5.5	47.0	57.5 79	42.9 77	68 78	59.7	6.4	58.0	35 76	39.6	3.0	38.0	MAR 11
MAR 21	10	49.4	7.3	48.0	66.1 78	37.5 75	73 78	61.8	6.7	61.0	25 75	39.1	7.3	39.5	MAR 21
APR 1	10	52.3	5.3	51.5	59.7 77	41.6 75	77 77	63.5	7.9	63.0	35 75	42.1	3.8	41.5	APR 1
APR 11	11	57.0	5.6	56.0	67.0 80	46.4 72	76 80	68.1	5.6	69.0	39 76	44.6	4.7	45.0	APR 11
APR 21	11	61.7	7.4	59.0	75.5 77	51.9 75	82 77	71.0	7.4	71.0	41 71	49.3	6.5	47.0	APR 21
MAY 1	10	62.6	4.5	61.0	68.9 71	54.8 75	82 81	73.0	5.1	73.0	42 78	51.8	7.5	51.5	MAY 1
MAY 11	10	65.9	7.7	65.5	77.5 73	52.4 74	85 75	77.3	6.8	77.5	46 77	52.2	5.3	50.5	MAY 11
MAY 21	10	68.5	4.0	68.5	74.5 79	61.2 77	85 79	79.9	4.5	81.0	48 71	55.3	4.8	54.5	MAY 21
JUN 1	11	73.9	5.7	73.0	85.6 77	67.2 80	96 77	83.7	4.9	83.0	54 81	63.2	7.1	61.0	JUN 1
JUN 11	11	74.0	7.5	73.0	92.8 74	65.3 81	98 74	84.1	6.4	85.0	49 76	61.1	10.6	64.0	JUN 11
JUN 21	11	79.8	5.4	78.0	86.9 74	69.8 75	96 79	89.8	4.7	90.0	54 71	66.8	6.6	69.0	JUN 21
JUL 1	9	82.9	4.8	82.0	91.1 75	76.2 78	99 81	92.0	5.2	94.0	61 77	70.6	6.6	70.0	JUL 1
JUL 11	9	86.4	3.1	86.0	92.3 73	81.6 80	103 73	95.0	4.6	95.0	65 74	76.1	6.5	76.0	JUL 11
JUL 21	9	88.6	3.3	88.0	94.0 80 M	85.0 77	100 80	95.4	3.6	95.0	64 77	79.0	8.1	82.0	JUL 21
AUG 1	10	87.3	5.4	87.5	94.4 78	76.3 76 M	100 81	95.0	3.9	95.5	65 74	78.5	8.3	80.0	AUG 1
AUG 11	10	84.6	6.8	83.5	92.8 81 M	74.7 76	98 77	92.6	5.1	93.5	62 80	74.9	9.5	77.0	AUG 11
AUG 21	10	81.7	5.9	79.5	93.0 81 M	74.5 77	99 81	91.0	5.8	91.5	59 74	68.7	8.7	66.0	AUG 21
SEP 1	10	81.2	2.7	81.0	86.2 81	76.7 72	94 81	90.1	2.0	90.0	56 80	69.1	8.4	67.0	SEP 1
SEP 11	10	74.7	8.4	73.0	91.0 81 M	59.3 78	97 81	85.4	7.1	86.5	44 78	60.0	9.5	57.5	SEP 11
SEP 21	10	70.2	8.4	73.0	79.3 74	59.5 72	90 79	80.4	6.6	80.5	43 72	58.6	10.7	61.5	SEP 21
OCT 1	10	69.4	6.6	68.5	80.5 79	61.0 77	86 79	78.5	5.1	79.5	42 71	56.2	10.6	53.5	OCT 1
OCT 11	10	63.5	4.9	63.5	70.3 78	57.7 80	82 79	74.1	4.6	75.0	42 80	51.4	7.5	52.0	OCT 11
OCT 21	11	54.1	5.4	55.0	62.1 78	45.6 75	70 78	64.1	4.9	64.0	29 71	42.4	5.8	43.0	OCT 21
NOV 1	9	49.8	6.7	48.0	57.7 80	37.8 73	65 78	55.8	6.5	54.0	28 73	41.7	8.5	41.0	NOV 1
NOV 11	9	43.2	3.7	42.0	51.4 76	39.2 78	60 76	52.0	5.1	51.0	25 78	35.0	5.0	36.0	NOV 11
NOV 21	10	38.0	2.7	37.5	41.5 80	33.2 79	55 76	49.0	4.3	49.0	23 79	28.4	3.6	29.0	NOV 21
DEC 1	10	36.5	7.4	37.0	47.2 75	22.6 72	59 75	47.1	6.5	48.0	4 72	25.3	10.9	29.0	DEC 1
DEC 11	9	34.4	5.5	35.0	41.6 79	22.5 72	53 79	43.1	4.5	42.0	2 72	24.8	9.4	29.0	DEC 11
DEC 21	10	34.4	4.7	33.5	44.3 80 M	29.1 78	53 80	45.1	4.4	44.0	3 78	23.3	8.9	24.0	DEC 21
MONTH															MONTH
JAN	10	32.6	4.4	33.0	38.1 81	22.9 79	58 78	48.2	5.4	48.5	0 79	13.5	8.5	12.0	JAN
FEB	9	41.1	3.0	40.0	47.2 77	37.1 75	64 77	53.3	4.5	52.0	13 79	24.2	8.8	27.0	FEB
MAR	10	48.6	4.5	47.0	55.5 78	43.2 76 M	73 78	63.2	6.0	62.5	25 75	33.5	5.1	34.0	MAR
APR	10	57.3	4.6	56.5	65.5 77	49.6 75	82 77	72.9	5.6	72.0	35 75	40.3	2.9	41.0	APR
MAY	10	65.7	3.4	65.5	70.5 76	61.1 78	85 79	81.4	3.7	81.5	42 78	48.0	5.1	47.0	MAY
JUN	11	75.9	4.3	75.0	83.9 74	70.9 75 M	98 74	91.0	5.3	91.0	49 76	57.5	6.8	56.0	JUN
JUL	9	86.0	1.7	85.0	89.1 75	83.0 77	103 73	98.3	2.7	98.0	61 77	68.1	4.9	69.0	JUL
AUG	10	84.4	4.5	83.0	92.4 81 M	77.4 76 M	100 81	95.9	3.3	96.5	59 74	67.5	9.0	63.0	AUG
SEP	10	75.5	4.4	74.5	81.3 79	68.7 72	97 81	90.4	2.8	90.0	43 72	53.7	9.2	53.0	SEP
OCT	10	62.0	3.7	61.0	68.9 78	56.9 75	86 79	79.3	3.5	79.5	29 71	42.4	5.8	43.0	OCT
NOV	8	43.8	3.4	42.5	49.5 76	38.8 73	65 78	57.3	6.0	58.0	23 79	27.3	3.6	26.0	NOV
DEC	9	34.7	4.1	36.0	39.5 75	28.4 72	59 75	48.8	5.5	49.0	2 72	18.6	9.6	23.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 105897 MIDDLE FORK LODGE — 1971-1981

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	10	6.8	10.0	8.0	22.9 81	-8.7 79	31 81	19.5	9.6	20.5	-23 79	-5.9	11.1	-1.0	JAN 1
JAN 11	10	16.8	4.9	16.0	25.3 78	8.3 79	34 74	29.0	4.3	29.5	-7 74	1.4	8.0	-1.0	JAN 11
JAN 21	10	11.7	8.5	12.0	23.5 74	-4.7 79	33 74	24.9	7.8	26.0	-21 79	-0.4	11.3	2.5	JAN 21
FEB 1	9	11.8	6.5	11.0	24.0 78	2.8 76	31 78	24.8	6.5	26.0	-19 79	-1.6	12.3	0.0	FEB 1
FEB 11	9	18.9	3.4	18.0	24.5 79	14.2 73	32 79	27.4	4.8	29.0	0 81	7.7	5.8	6.0	FEB 11
FEB 21	9	17.8	5.9	17.0	25.6 81	7.5 75	34 72	27.2	4.4	26.0	-1 75	10.4	8.8	12.0	FEB 21
MAR 1	10	21.6	4.7	22.0	26.4 80	9.4 76	36 77	30.7	3.4	31.0	-3 76	13.3	7.4	15.5	MAR 1
MAR 11	10	23.2	3.9	22.5	31.5 72	17.6 77	36 74	30.2	3.7	29.5	12 77	17.3	5.0	17.0	MAR 11
MAR 21	10	23.8	4.1	23.0	29.7 78	16.6 75	36 78	30.6	3.1	29.5	2 75	17.6	7.6	19.0	MAR 21
APR 1	10	26.5	2.9	26.0	31.8 78	20.9 75	37 78	32.3	2.2	32.0	11 75	21.0	5.1	20.5	APR 1
APR 11	11	27.5	1.8	27.0	29.1 80	22.5 72	42 81	34.9	3.0	34.0	18 72	22.7	1.8	23.0	APR 11
APR 21	11	31.9	4.0	31.0	38.2 81	25.5 72	42 81	36.5	4.5	37.0	21 75	27.7	4.2	27.0	APR 21
MAY 1	10	32.6	2.5	32.5	35.7 77	26.7 72	43 81	38.6	3.8	39.0	20 72	26.7	2.8	27.0	MAY 1
MAY 11	10	34.0	2.5	34.5	37.3 78	28.7 74	46 78	39.6	3.9	40.0	22 74	28.1	2.8	28.0	MAY 11
MAY 21	10	36.1	3.2	35.0	43.1 81	31.0 75	48 81	42.6	3.1	43.0	26 75	29.8	3.5	29.5	MAY 21
JUN 1	11	38.9	5.1	37.0	48.4 77	29.0 75	55 77	45.3	5.2	45.0	22 75	32.9	5.3	33.0	JUN 1
JUN 11	11	40.1	3.1	39.0	46.9 77	36.1 78	52 77	45.6	3.5	46.0	29 72	34.5	3.3	34.0	JUN 11
JUN 21	11	42.2	2.9	41.0	47.2 73	37.4 72	51 73	47.6	2.9	49.0	29 75	36.0	3.3	37.0	JUN 21
JUL 1	9	43.6	2.8	43.0	46.9 80	37.9 71	54 81	50.2	3.2	50.0	31 81	35.9	4.2	36.0	JUL 1
JUL 11	9	46.3	3.2	44.0	50.3 75	42.3 74	65 77	53.7	6.6	54.0	34 74	40.2	4.1	40.0	JUL 11
JUL 21	9	47.3	2.5	47.0	50.9 77	42.1 81 M	58 77	51.0	3.8	51.0	39 81	43.4	2.7	43.0	JUL 21
AUG 1	10	45.9	2.3	46.0	49.1 77	42.4 75	56 77	51.9	3.6	53.0	37 80	41.1	3.0	41.5	AUG 1
AUG 11	10	43.5	4.2	43.5	49.3 72	36.9 75	56 72	48.5	4.6	48.5	32 75	39.0	4.4	38.5	AUG 11
AUG 21	10	40.9	2.8	41.0	43.7 73	34.3 75	50 77	45.9	3.7	46.5	32 77	35.8	3.3	35.5	AUG 21
SEP 1	10	38.6	3.2	37.5	43.8 78	34.1 75	53 80	44.4	5.1	44.0	28 76	32.8	2.7	33.0	SEP 1
SEP 11	10	36.6	4.0	36.0	43.8 80	28.4 71	54 80	43.6	5.2	42.5	22 71	30.2	4.8	30.5	SEP 11
SEP 21	10	33.2	3.7	32.5	39.4 76	27.8 71	48 76	38.6	4.7	38.5	24 72	28.1	4.5	26.5	SEP 21
OCT 1	10	30.6	2.4	29.5	34.2 79	26.4 81 M	42 75	37.6	2.4	38.0	19 81	25.7	3.6	26.5	OCT 1
OCT 11	10	30.3	4.2	29.0	37.0 72	25.2 76	43 73	36.4	4.7	35.5	18 76	25.1	4.4	23.5	OCT 11
OCT 21	11	25.9	3.5	25.0	30.6 77	20.2 71	41 77	34.0	3.1	33.0	4 71	19.5	6.7	19.0	OCT 21
NOV 1	9	24.6	4.8	24.0	31.1 80	15.4 71	42 76	33.4	5.2	34.0	6 71	17.4	6.1	17.0	NOV 1
NOV 11	9	22.4	5.4	21.0	29.9 73	15.0 79	38 73	30.8	4.4	31.0	4 78	13.2	6.6	12.0	NOV 11
NOV 21	10	17.1	5.0	17.5	23.6 71	7.6 79	33 74	26.0	4.9	26.5	-5 79	6.8	8.0	9.5	NOV 21
DEC 1	10	16.3	7.5	16.5	24.4 75	2.4 72	33 80	29.2	3.8	30.0	-15 72	2.8	10.5	4.5	DEC 1
DEC 11	9	14.0	6.1	14.0	24.5 73	5.5 72	32 73	25.0	4.9	25.0	-18 72	4.1	10.8	9.0	DEC 11
DEC 21	10	15.6	7.7	13.0	30.8 80 M	4.7 78	34 80	28.6	3.8	27.5	-21 78	3.8	12.5	3.5	DEC 21
MONTH															MONTH
JAN	10	11.8	5.9	11.5	19.9 81	-1.8 79	34 74	30.3	3.0	31.0	-23 79	-9.1	8.8	-1.0	JAN
FEB	9	16.1	2.7	16.0	20.0 78	11.8 76	34 72	30.9	2.0	31.0	-19 79	-4.0	9.2	0.0	FEB
MAR	10	22.9	2.8	23.5	25.7 81	16.4 76 M	36 78	33.3	2.9	33.0	-3 76	10.2	7.1	12.0	MAR
APR	10	28.6	2.3	28.5	31.8 78	24.9 72	42 81	37.7	3.3	38.0	11 75	19.7	3.9	20.5	APR
MAY	10	34.3	1.9	34.0	37.3 81	31.6 72	48 81	43.2	2.8	43.0	20 72	25.8	3.0	26.5	MAY
JUN	11	40.4	2.8	39.0	47.3 77	35.8 75 M	55 77	49.2	2.8	50.0	22 75	31.5	4.6	32.0	JUN
JUL	9	45.8	1.8	46.0	48.0 77	43.4 71	65 77	55.7	4.7	54.0	31 81	35.8	4.0	36.0	JUL
AUG	10	43.4	2.6	44.0	46.5 72	37.7 75	56 77	52.3	3.6	53.0	32 77	35.1	2.7	35.0	AUG
SEP	10	36.1	2.9	36.5	39.8 80	30.5 71	54 80	45.8	4.8	45.0	22 71	26.7	3.1	26.5	SEP
OCT	10	28.7	2.5	28.5	32.9 79	25.7 71	43 73	39.1	3.1	38.5	4 71	18.3	6.3	18.0	OCT
NOV	8	21.6	3.1	21.5	25.2 73	15.2 79	42 76	34.9	4.1	34.5	-5 79	4.9	6.6	5.0	NOV
DEC	9	14.7	5.0	15.0	22.7 73	6.8 78	34 80	29.8	3.4	30.0	-21 78	-3.3	10.3	0.0	DEC

(con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 107706 RIGGINS — 1951-1980

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	29	39.1	6.8	39.0	52.2 54 M	21.3 74	64 53	47.0	8.0	48.0	12 79	30.5	7.2	32.0	JAN 1
JAN 11	29	42.9	5.4	44.0	52.9 53 M	29.8 63	64 53	50.6	6.2	51.0	17 63	35.0	6.8	35.0	JAN 11
JAN 21	28	42.3	5.7	42.5	53.1 53	28.6 57	62 53	51.0	5.8	52.0	10 62	32.8	8.6	34.5	JAN 21
FEB 1	28	47.5	5.6	47.0	59.1 63	37.8 56	67 63	55.6	5.6	54.5	23 76	39.3	8.5	41.0	FEB 1
FEB 11	29	49.8	4.7	49.0	61.7 77	39.3 56	72 77	57.9	4.3	57.0	27 56	42.5	6.5	42.0	FEB 11
FEB 21	26	52.4	6.3	52.5	61.3 63	34.0 60	69 54	60.1	5.8	59.5	20 60	45.0	8.4	46.0	FEB 21
MAR 1	26	52.6	5.2	51.5	62.7 68	41.4 51	76 72	60.9	7.1	60.5	34 51	43.3	4.5	43.5	MAR 1
MAR 11	27	56.0	4.2	56.0	67.6 72	49.7 52	76 78	65.5	4.5	64.0	34 65	46.1	5.7	46.0	MAR 11
MAR 21	28	60.0	5.9	59.5	73.7 78	47.1 75	83 78	69.9	7.8	69.5	38 65	48.6	5.3	48.5	MAR 21
APR 1	27	63.8	6.0	62.0	77.2 60 M	49.5 75	84 77	73.6	6.9	75.0	42 76	52.7	6.0	52.0	APR 1
APR 11	27	64.5	5.7	64.0	80.4 62 M	52.2 55 M	90 62	74.5	7.5	76.0	44 72	54.1	5.1	54.0	APR 11
APR 21	27	66.8	7.3	67.0	85.3 77	55.0 67	95 77	77.7	8.3	78.0	44 75	55.2	6.5	54.0	APR 21
MAY 1	30	70.5	6.5	71.0	88.3 66	58.9 52 M	97 66	82.0	6.9	82.0	45 64	57.7	7.7	57.0	MAY 1
MAY 11	30	74.3	6.0	74.0	87.8 73	62.8 74	98 54	86.0	6.3	87.5	50 77	60.8	6.4	61.0	MAY 11
MAY 21	30	76.0	6.1	75.0	90.8 58	66.9 53 M	99 66	87.6	6.4	88.5	49 80	62.9	7.7	61.5	MAY 21
JUN 1	30	79.7	6.5	80.0	90.0 69	68.1 54 M	102 57	89.5	6.1	89.5	54 54	68.1	7.9	69.0	JUN 1
JUN 11	30	81.7	5.9	79.0	98.9 74	74.3 52	104 74	91.5	5.0	91.0	55 79	68.9	8.7	67.5	JUN 11
JUN 21	30	85.0	5.6	84.0	94.1 61	73.3 69	106 70	95.1	6.9	96.0	59 75	73.2	7.7	73.0	JUN 21
JUL 1	30	89.3	5.3	89.5	100.2 68	75.1 55	110 73	98.2	5.0	98.5	64 78	78.8	6.5	79.5	JUL 1
JUL 11	30	93.5	4.2	92.5	103.4 60	86.0 80	110 67	101.9	4.6	100.0	72 76	83.1	6.6	82.0	JUL 11
JUL 21	30	95.9	3.3	96.0	102.5 51	89.5 70	111 59	103.0	3.7	100.0	70 64	86.2	6.9	88.0	JUL 21
AUG 1	30	95.1	4.2	96.0	104.2 71	86.4 76	114 61	102.5	4.9	100.0	75 76	86.4	6.2	87.0	AUG 1
AUG 11	30	93.0	6.3	93.0	104.8 67	79.8 78	108 71	100.8	4.8	100.0	62 68	83.2	9.7	84.0	AUG 11
AUG 21	30	88.0	6.3	86.5	98.8 70	77.0 60 M	112 69	98.5	6.7	98.0	63 64	76.3	8.1	75.0	AUG 21
SEP 1	30	86.6	4.8	86.0	97.8 55	75.1 64	105 67	96.5	4.6	96.5	58 64	73.5	7.1	73.0	SEP 1
SEP 11	30	80.7	6.1	80.0	94.1 53	66.6 78	101 53	91.1	5.8	92.0	56 65	68.7	6.7	69.0	SEP 11
SEP 21	30	78.1	8.2	78.0	94.3 67	63.1 77	99 66	86.6	7.1	86.0	50 68	67.8	10.2	66.5	SEP 21
OCT 1	30	73.7	6.1	73.5	85.3 65	63.0 77	95 63	82.7	5.9	83.0	50 75	62.4	7.8	60.5	OCT 1
OCT 11	30	67.9	5.1	68.5	78.0 63	58.2 69	84 79	76.0	5.5	75.5	50 71	58.1	5.4	56.5	OCT 11
OCT 21	30	61.7	5.2	61.0	71.0 52	50.2 61	76 68	70.4	5.2	72.0	35 71	53.0	6.9	52.5	OCT 21
NOV 1	27	55.7	4.0	55.0	63.3 65	46.2 73	71 80	63.0	3.9	62.0	37 78	48.3	5.3	50.0	NOV 1
NOV 11	25	50.3	5.6	49.0	58.1 74	32.2 55	69 53	59.4	4.6	60.0	16 55	42.1	8.2	44.0	NOV 11
NOV 21	27	46.9	3.5	47.0	53.5 53 M	39.3 78	67 74	55.1	5.4	56.0	28 77	39.4	4.9	40.0	NOV 21
DEC 1	27	44.0	5.4	44.0	51.4 65	25.4 72	63 68	52.7	5.4	53.0	13 72	36.0	7.5	38.0	DEC 1
DEC 11	27	42.8	4.8	44.0	50.3 69	32.0 67	59 69	50.7	4.2	51.0	14 64	34.5	8.0	36.0	DEC 11
DEC 21	27	42.0	4.5	42.0	53.3 80	32.1 68 M	63 80	51.1	5.5	50.0	11 78	33.2	7.5	34.0	DEC 21
MONTH															MONTH
JAN	28	41.5	4.5	41.0	51.9 53 M	29.5 79	64 53	54.1	4.4	53.0	10 62	26.0	7.4	27.0	JAN
FEB	25	50.2	4.0	49.0	57.9 63	41.6 56	72 77	62.3	5.1	62.0	20 60	37.1	7.6	40.0	FEB
MAR	26	56.2	3.6	55.0	63.6 78	49.7 52 M	83 78	70.8	6.5	69.5	34 65	41.2	4.2	40.0	MAR
APR	27	65.0	4.8	65.0	74.8 62 M	55.7 75	95 77	80.4	6.6	79.0	42 76	49.1	4.2	50.0	APR
MAY	30	73.7	4.2	73.0	85.3 58	66.0 59	99 66	90.0	5.0	91.0	45 64	54.7	6.0	54.0	MAY
JUN	30	82.1	3.7	82.5	89.8 61	76.4 54 M	106 70	97.5	5.1	98.0	54 54	63.0	5.7	62.0	JUN
JUL	30	93.0	2.7	92.0	99.0 60	87.2 55	111 59	104.9	3.3	100.0	64 78	76.2	5.5	76.0	JUL
AUG	30	91.9	4.3	91.0	100.5 71	83.7 75	114 61	104.4	4.4	100.0	62 68	74.8	7.8	75.0	AUG
SEP	30	82.0	4.7	81.5	92.4 67	73.8 70	105 67	97.1	4.2	97.5	50 68	63.5	6.6	62.0	SEP
OCT	30	67.8	4.2	67.0	76.2 79 M	61.1 69	95 63	83.2	5.0	83.5	35 71	51.7	5.2	52.0	OCT
NOV	23	51.2	2.8	51.0	55.8 65	44.9 78	71 80	64.3	3.7	64.0	16 55	38.3	4.9	40.0	NOV
DEC	27	42.9	3.3	43.0	47.5 80	34.2 78	63 80	56.0	4.1	56.0	11 78	28.5	8.0	32.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 107706 RIGGINS — 1951-1980

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG, YR	LOWEST AVG, YR	HIGH, YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW, YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	29	26.0	6.8	26.0	36.3 54 M	7.8 79	46 53	34.8	6.7	37.0	-7 79	15.7	8.8	16.0	JAN 1
JAN 11	29	29.6	5.7	30.0	40.8 53 M	12.2 63	48 59	36.8	5.6	37.0	-6 63	20.0	8.9	22.0	JAN 11
JAN 21	28	27.1	7.1	28.0	39.1 53	7.6 57	48 53	36.3	6.1	36.0	-10 57	15.8	10.6	20.0	JAN 21
FEB 1	28	30.3	5.2	30.5	38.6 61	15.7 76	48 68	37.5	5.3	37.0	2 56	21.8	8.3	24.0	FEB 1
FEB 11	29	31.6	4.0	31.0	37.9 70	22.8 56	50 70	39.1	4.4	39.0	-3 56	22.7	7.5	24.0	FEB 11
FEB 21	26	31.3	5.4	32.0	38.0 58	11.4 60	46 72	39.0	4.7	39.0	2 60	24.7	7.0	27.5	FEB 21
MAR 1	26	31.6	3.6	31.0	38.1 72	21.7 76	48 72	39.3	5.0	39.5	15 76	24.3	4.3	24.5	MAR 1
MAR 11	27	32.9	3.8	32.0	43.4 72	26.5 65	49 74	40.4	4.2	39.0	14 65	25.2	5.1	26.0	MAR 11
MAR 21	28	35.8	4.0	36.0	44.5 78	26.2 75	53 78	43.7	4.2	44.0	16 75	28.3	5.1	28.5	MAR 21
APR 1	28	37.4	2.6	37.0	43.2 60 M	30.9 75	50 61	44.0	3.4	44.0	18 72	30.3	4.7	31.0	APR 1
APR 11	28	37.7	2.5	38.0	41.7 52	33.4 68	53 54	45.6	4.3	46.5	23 68	30.5	3.0	30.0	APR 11
APR 21	28	40.2	3.4	40.0	48.5 77	33.3 76	56 77	47.6	4.7	48.0	25 51	33.3	3.4	34.0	APR 21
MAY 1	30	44.2	3.3	44.0	50.4 80	37.3 65	61 66	51.6	4.3	52.0	30 67	37.0	3.7	37.0	MAY 1
MAY 11	30	45.7	3.3	45.0	52.4 54 M	37.9 53 M	60 68	53.4	4.0	53.0	30 74	38.1	4.0	38.5	MAY 11
MAY 21	30	47.5	3.6	47.0	56.8 58	41.5 53 M	65 58	55.6	3.5	55.0	32 64	40.0	4.6	40.0	MAY 21
JUN 1	30	50.8	3.5	50.0	57.4 69	44.5 51	68 77	58.0	3.9	58.0	33 55	43.5	4.3	43.0	JUN 1
JUN 11	30	52.9	3.3	52.0	59.7 63	47.4 53 M	68 67	59.8	3.3	59.0	40 78	46.4	4.1	46.5	JUN 11
JUN 21	30	54.0	3.5	53.0	62.5 73	47.9 75	71 70	61.6	3.8	61.0	39 76	45.7	4.2	45.5	JUN 21
JUL 1	30	56.9	3.0	57.0	62.9 75	48.3 55	72 70	64.7	4.0	65.0	42 71	48.4	3.3	49.5	JUL 1
JUL 11	30	59.7	2.7	59.0	64.8 60	55.2 62	74 74	66.9	3.2	67.0	48 74	53.0	3.4	52.0	JUL 11
JUL 21	30	60.6	2.3	60.5	64.8 60	55.5 63	75 62	67.3	3.6	67.0	46 59	53.7	3.7	54.0	JUL 21
AUG 1	30	60.0	3.5	59.0	67.8 71	52.7 56	76 66	67.1	4.7	67.5	47 56	54.1	4.2	53.5	AUG 1
AUG 11	30	59.0	3.5	59.0	65.2 61	51.0 78	73 61	65.2	4.2	65.0	43 68	53.3	4.6	53.5	AUG 11
AUG 21	30	55.7	3.4	54.0	64.2 61	50.3 60 M	74 67	63.5	4.7	63.0	43 80	48.3	3.9	48.0	AUG 21
SEP 1	30	53.7	3.2	52.0	62.8 67	48.8 56	70 55	61.3	3.8	60.0	40 56	46.0	4.0	45.5	SEP 1
SEP 11	30	50.5	3.8	51.0	57.0 66	41.2 70	68 59	57.5	4.3	57.5	30 65	42.6	5.2	42.5	SEP 11
SEP 21	30	48.0	4.5	47.5	55.9 63	41.7 58 M	65 52	55.3	4.6	56.0	34 61	40.6	4.6	40.0	SEP 21
OCT 1	30	44.9	3.3	45.5	50.8 63	37.6 74	65 63	53.4	4.6	53.0	28 74	37.2	4.4	38.0	OCT 1
OCT 11	30	42.2	3.7	42.0	49.8 63	31.3 69	61 63	50.7	5.0	50.0	24 69	34.8	4.1	34.0	OCT 11
OCT 21	30	39.4	4.0	39.0	47.9 57	31.9 71	58 63	47.6	5.0	46.0	16 71	31.6	5.5	32.0	OCT 21
NOV 1	27	36.8	4.3	35.0	45.3 58 M	28.1 57 M	55 58	46.4	3.9	46.0	20 71	28.7	5.1	28.0	NOV 1
NOV 11	25	34.2	6.0	35.0	41.9 65	15.6 55	52 63	43.3	4.5	44.0	-2 55	24.9	8.0	26.0	NOV 11
NOV 21	27	31.2	5.3	32.0	38.1 66	19.2 59 M	48 68	38.9	5.7	40.0	7 59	22.5	6.2	22.0	NOV 21
DEC 1	27	30.2	5.1	31.0	36.1 62	12.8 72	46 65	38.9	4.0	40.0	-5 72	21.6	8.0	24.0	DEC 1
DEC 11	27	29.5	5.4	29.0	37.8 73	17.2 67	44 73	37.3	3.5	38.0	-8 64	19.5	9.8	22.0	DEC 11
DEC 21	27	29.6	4.9	30.0	38.7 80 M	17.6 78	45 80	37.7	4.5	38.0	-4 68	19.5	8.6	20.0	DEC 21
MONTH															MONTH
JAN	28	27.6	4.9	27.0	38.6 53 M	14.4 79	48 59	39.6	4.8	39.5	-10 57	9.0	9.6	9.5	JAN
FEB	25	31.4	3.3	32.0	36.1 61	24.0 76	50 70	42.3	4.0	43.0	-3 56	18.4	8.0	19.0	FEB
MAR	26	33.5	3.2	33.0	38.7 72	26.4 76 M	53 78	44.8	4.0	45.5	14 65	22.5	4.4	23.0	MAR
APR	28	38.5	2.1	38.0	41.9 77	33.5 76	56 77	48.9	4.0	49.5	18 72	27.9	3.7	28.0	APR
MAY	30	45.9	2.2	46.0	50.0 58	40.4 53 M	65 58	56.9	3.3	57.0	30 74	34.9	2.9	35.0	MAY
JUN	30	52.6	2.4	52.0	57.2 77	48.3 53 M	71 70	63.2	3.2	62.0	33 55	41.7	3.3	41.0	JUN
JUL	30	59.1	1.6	58.0	63.0 60	55.8 55	75 62	69.6	2.6	70.0	42 71	47.9	2.9	48.0	JUL
AUG	30	58.1	2.8	58.0	64.5 61	53.7 78	76 66	68.7	4.0	69.0	43 80	47.8	3.7	47.5	AUG
SEP	30	50.8	2.9	50.0	56.8 63	45.9 70	70 55	61.9	3.8	61.0	30 65	38.8	4.1	39.5	SEP
OCT	30	42.2	2.6	41.5	47.6 79 M	37.3 75	65 63	54.6	4.2	54.5	16 71	30.1	4.8	31.5	OCT
NOV	23	34.7	3.4	34.0	40.0 65	27.8 75	55 58	47.6	3.5	47.0	-2 55	21.7	5.1	22.0	NOV
DEC	27	29.8	3.5	29.0	35.9 58	20.6 78	46 65	41.3	2.9	41.0	-8 64	13.5	9.3	16.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 108076 SALMON - SALMON 1 N

1951-1980

		10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	I	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	30	27.3	9.4	27.5	42.8 66	3.5 74	I	56 53	39.7	9.6	41.0	-11 79	14.3	10.8	15.0	JAN 1
JAN 11	30	32.8	7.4	35.0	47.6 53	13.1 63	I	62 53	43.9	6.8	45.0	-4 63	20.6	9.7	22.0	JAN 11
JAN 21	30	30.3	7.9	31.0	45.8 53	11.5 79	I	59 53	43.4	7.7	43.0	-7 62	17.6	11.2	20.5	JAN 21
FEB 1	30	35.5	6.2	34.0	47.4 63	17.3 56	I	63 61	46.2	6.5	45.5	-3 56	25.6	10.6	28.5	FEB 1
FEB 11	30	39.5	5.3	39.5	50.0 77	28.8 55	I	58 70	49.6	5.0	49.5	10 56	30.5	7.4	30.5	FEB 11
FEB 21	30	41.8	7.2	42.5	53.5 54	24.2 60	I	60 80	50.8	6.5	52.0	12 60	34.0	8.6	35.5	FEB 21
MAR 1	30	43.1	5.7	43.0	55.3 68	32.7 60	I	69 72	53.1	7.4	52.5	14 60	33.3	7.8	32.5	MAR 1
MAR 11	30	47.5	5.0	47.0	58.2 72	38.9 52	I	67 72	57.3	5.6	57.0	25 60	37.6	6.6	38.0	MAR 11
MAR 21	30	53.4	5.5	53.0	66.8 78	42.1 75	I	76 78	65.0	5.6	66.0	28 65	42.2	6.8	43.0	MAR 21
APR 1	30	57.7	4.8	56.5	68.3 60	46.8 75	I	83 77	69.1	6.6	69.0	37 75	46.7	5.1	47.0	APR 1
APR 11	30	60.2	6.0	58.0	74.4 62	48.7 70	I	86 80	71.1	6.7	70.5	37 66	48.9	5.6	48.5	APR 11
APR 21	30	62.2	6.7	61.5	79.1 77	49.9 67	I	87 77	74.6	7.4	75.5	40 67	49.2	7.1	47.0	APR 21
MAY 1	30	67.2	5.7	67.0	79.3 66	54.4 64	I	88 66	78.2	5.6	78.0	39 64	54.7	6.3	55.0	MAY 1
MAY 11	30	70.1	5.9	68.5	83.8 54	55.4 74	I	95 54	81.8	6.2	83.5	44 55	56.2	6.7	55.0	MAY 11
MAY 21	30	71.7	5.3	70.5	82.5 58	63.8 53	I	92 56	83.4	5.0	85.0	48 53	59.0	5.9	58.0	MAY 21
JUN 1	30	75.4	6.7	76.0	84.4 77	63.6 51	I	96 77	85.8	6.4	87.0	53 64	63.7	7.4	63.0	JUN 1
JUN 11	30	77.8	5.9	77.0	96.3 74	66.7 64	I	103 74	87.8	5.7	87.5	56 64	65.7	6.6	66.0	JUN 11
JUN 21	30	80.3	5.9	80.0	91.1 61	66.5 69	I	99 74	91.3	5.3	92.0	52 55	67.4	8.9	67.0	JUN 21
JUL 1	30	85.4	5.3	85.5	93.4 75	70.9 55	I	105 73	93.9	4.7	94.5	59 55	74.6	7.2	75.0	JUL 1
JUL 11	30	89.3	3.9	89.0	97.3 60	82.1 63	I	105 60	97.2	3.7	97.0	65 72	78.9	6.1	79.0	JUL 11
JUL 21	30	90.7	2.7	90.0	94.9 80	85.2 70	I	103 59	97.4	3.1	97.5	70 75	81.6	5.9	83.0	JUL 21
AUG 1	30	88.7	3.6	88.5	94.7 79	81.1 56	I	103 61	96.6	3.2	97.0	70 74	78.9	5.4	80.5	AUG 1
AUG 11	30	87.0	5.6	87.0	96.1 67	72.1 68	I	101 73	94.7	4.0	96.0	59 68	76.4	9.8	78.0	AUG 11
AUG 21	30	82.1	5.5	81.5	92.1 69	72.8 65	I	102 69	92.0	4.6	92.5	55 64	70.3	7.7	70.0	AUG 21
SEP 1	30	80.8	4.8	80.5	90.8 55	69.1 65	I	97 55	90.1	3.9	90.0	59 73	70.1	6.2	69.5	SEP 1
SEP 11	30	73.9	5.6	74.0	84.3 53	59.5 65	I	93 59	85.5	4.1	86.0	42 65	59.6	7.5	60.0	SEP 11
SEP 21	30	71.5	7.1	72.0	83.9 52	59.5 61	I	90 67	81.2	5.7	82.0	45 68	60.4	8.9	60.5	SEP 21
OCT 1	30	68.2	5.4	69.0	78.1 52	57.7 59	I	86 57	78.0	5.3	80.0	43 66	56.3	7.4	55.5	OCT 1
OCT 11	30	62.7	5.0	62.5	71.6 58	49.7 69	I	79 58	72.2	5.0	72.0	42 69	52.6	5.6	53.0	OCT 11
OCT 21	30	55.2	4.9	55.0	65.2 52	45.1 70	I	78 77	65.7	5.2	65.0	30 71	45.9	6.2	45.5	OCT 21
NOV 1	30	49.3	4.0	48.0	58.8 54	42.6 73	I	68 54	58.0	4.7	56.5	28 78	40.6	6.4	41.5	NOV 1
NOV 11	30	43.4	5.8	42.5	57.1 54	29.1 55	I	68 53	53.5	6.0	54.0	9 55	32.8	8.4	34.0	NOV 11
NOV 21	30	38.8	5.0	39.0	46.4 54	28.6 52	I	61 74	50.1	6.8	49.0	14 77	28.5	6.9	30.0	NOV 21
DEC 1	30	35.7	5.4	36.0	44.1 79	17.9 72	I	57 79	47.3	5.5	47.0	2 72	24.8	9.1	27.0	DEC 1
DEC 11	30	32.5	5.5	33.0	41.9 79	21.6 67	I	53 57	43.0	5.2	43.0	-2 64	21.9	9.2	24.0	DEC 11
DEC 21	30	31.5	4.3	31.5	41.9 80	23.1 78	I	55 55	43.6	4.8	43.0	-6 78	19.3	7.9	20.5	DEC 21
MONTH							I									MONTH
JAN	30	30.1	5.7	29.5	42.9 53	13.9 79	I	62 53	47.9	5.7	47.5	-11 79	8.7	9.7	8.0	JAN
FEB	30	38.8	4.5	38.5	46.9 63	29.3 56	I	63 61	53.4	5.0	54.5	-3 56	23.0	10.3	26.0	FEB
MAR	30	48.2	4.2	48.0	56.5 68	39.4 52	I	76 78	65.4	5.1	66.0	14 60	31.4	6.4	31.0	MAR
APR	30	60.0	4.2	59.0	68.1 77	52.8 75	I	87 77	76.6	6.0	77.0	37 75	43.6	3.5	43.0	APR
MAY	30	69.7	3.7	69.0	78.7 58	64.4 53	I	95 54	85.9	3.9	86.0	39 64	51.3	4.7	51.0	MAY
JUN	30	77.8	4.0	77.0	87.4 74	70.8 64	I	103 74	93.6	3.7	93.5	52 55	59.0	4.5	59.0	JUN
JUL	30	88.5	2.6	88.0	92.9 60	83.9 62	I	105 73	99.4	2.9	99.0	59 55	72.0	6.2	72.5	JUL
AUG	30	85.8	3.7	85.0	91.9 69	80.1 68	I	103 61	97.7	2.7	97.0	55 64	68.3	7.5	67.5	AUG
SEP	30	75.4	4.6	76.0	84.6 79	63.8 65	I	97 55	90.4	3.7	90.0	42 65	56.0	6.9	56.0	SEP
OCT	30	61.8	3.6	61.5	70.5 52	53.8 69	I	86 57	78.6	4.3	80.0	30 71	44.9	4.9	45.5	OCT
NOV	30	43.8	3.4	43.0	54.1 54	37.4 55	I	68 54	59.2	4.4	59.5	9 55	26.1	6.8	27.0	NOV
DEC	30	33.2	3.6	33.0	39.8 79	24.7 78	I	57 79	49.6	4.1	50.0	-6 78	15.4	8.8	19.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 108076 SALMON - SALMON 1 N

1951-1980

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	30	6.3	10.6	5.0	24.9 66	-18.1 74	39 66	22.4	10.5	23.0	-34 79	-8.6	12.4	-1.0	JAN 1
JAN 11	30	12.6	10.1	14.5	31.2 53	-11.4 60	38 53	25.2	8.9	27.5	-27 60	-2.7	12.6	-1.0	JAN 11
JAN 21	30	9.2	11.0	8.0	27.7 53	-13.2 57	35 72	23.8	8.7	22.0	-32 62	-6.2	14.9	-1.0	JAN 21
FEB 1	30	13.4	9.0	13.5	26.4 53	-12.2 56	34 71	25.8	7.1	27.0	-35 56	0.7	13.2	2.0	FEB 1
FEB 11	30	18.3	6.8	18.5	27.3 70	2.4 52	38 70	29.0	5.5	30.0	-20 56	5.6	9.5	4.0	FEB 11
FEB 21	30	18.5	8.8	21.0	27.9 80	-5.6 60	36 72	28.1	5.9	30.0	-25 60	9.7	12.1	13.0	FEB 21
MAR 1	30	20.0	6.1	21.0	29.1 80	1.6 52	38 74	30.3	4.4	31.0	-20 60	9.4	10.0	10.0	MAR 1
MAR 11	30	22.0	4.7	22.0	33.9 72	12.9 56	39 74	30.9	4.1	30.5	-5 60	11.4	7.5	13.0	MAR 11
MAR 21	30	25.4	3.3	25.0	33.1 78	19.4 55	44 66	34.5	4.0	33.0	5 75	15.9	5.5	17.0	MAR 21
APR 1	30	28.4	3.0	28.0	35.4 78	22.3 52	45 77	37.7	4.2	37.5	12 59	19.8	4.3	20.0	APR 1
APR 11	30	29.5	2.4	29.5	33.7 69	24.4 70	45 68	38.5	4.0	39.0	14 66	20.2	2.8	20.0	APR 11
APR 21	30	32.9	3.0	32.0	39.4 80	28.3 58	49 80	41.7	4.2	42.0	18 68	25.1	4.4	25.0	APR 21
MAY 1	30	36.1	3.5	36.0	44.4 80	28.9 65	51 67	44.1	3.8	44.5	19 72	26.9	4.4	27.0	MAY 1
MAY 11	30	37.8	2.3	37.5	43.2 57	33.6 60	54 58	46.5	4.1	47.0	24 73	30.2	3.7	30.5	MAY 11
MAY 21	30	40.2	2.6	40.0	47.1 56	34.3 54	56 80	49.3	3.0	48.5	25 75	31.6	4.0	31.0	MAY 21
JUN 1	30	43.4	3.7	43.0	52.3 77	36.1 54	59 77	50.2	3.7	49.5	25 54	35.8	5.0	37.0	JUN 1
JUN 11	30	45.0	2.6	44.0	51.2 74	39.5 54	57 74	51.3	2.6	51.0	29 54	37.7	4.3	38.0	JUN 11
JUN 21	30	45.9	3.5	45.5	53.6 70	38.2 53	62 66	53.8	3.6	54.0	30 52	37.5	4.2	37.0	JUN 21
JUL 1	30	47.2	3.4	46.5	55.0 75	40.2 59	62 68	54.8	3.9	55.0	26 55	39.6	4.5	40.0	JUL 1
JUL 11	30	49.9	2.8	50.0	55.4 75	45.7 52	64 51	57.5	3.5	58.0	38 51	43.2	3.4	43.0	JUL 11
JUL 21	30	50.0	2.5	50.0	54.1 75	43.8 54	67 78	57.8	3.7	57.5	32 59	43.5	3.8	44.0	JUL 21
AUG 1	30	49.0	3.1	47.0	54.5 68	42.6 56	65 70	57.2	3.9	57.0	35 56	42.8	3.2	43.0	AUG 1
AUG 11	30	47.6	2.6	47.0	54.5 72	43.1 59	62 69	55.3	3.5	55.0	32 59	41.6	3.4	42.5	AUG 11
AUG 21	30	44.6	2.9	43.5	50.1 69	37.5 60	70 69	52.9	4.4	53.0	28 60	37.2	4.0	37.0	AUG 21
SEP 1	30	41.6	3.5	41.0	49.9 78	35.8 56	60 78	50.7	4.5	50.0	27 59	33.9	3.5	33.5	SEP 1
SEP 11	30	39.0	3.7	38.5	47.0 80	31.9 65	58 66	47.5	4.2	48.0	18 65	30.5	4.9	30.0	SEP 11
SEP 21	30	35.9	3.6	35.0	41.8 67	29.5 61	53 76	45.1	4.7	45.0	21 61	28.7	4.6	28.0	SEP 21
OCT 1	30	32.2	3.6	31.0	44.0 63	25.8 59	53 75	41.9	4.8	41.0	19 74	24.3	3.8	24.0	OCT 1
OCT 11	30	29.9	4.2	30.0	36.7 79	20.0 69	51 62	40.5	5.7	40.0	13 69	22.1	4.6	22.5	OCT 11
OCT 21	30	26.6	3.1	26.0	32.7 77	18.6 58	45 75	37.5	4.2	38.0	3 71	17.8	5.2	18.0	OCT 21
NOV 1	30	23.5	5.4	23.5	33.7 76	11.3 52	43 76	33.1	6.0	34.0	3 55	14.8	5.7	14.5	NOV 1
NOV 11	30	22.1	6.1	22.5	32.8 54	10.5 55	42 54	32.5	4.4	33.5	-9 55	11.1	8.5	11.5	NOV 11
NOV 21	30	18.3	6.2	19.0	27.2 55	-1.8 52	35 74	28.6	5.5	30.5	-12 52	6.2	7.6	7.0	NOV 21
DEC 1	30	15.8	6.9	16.5	25.8 62	-3.9 72	36 80	28.2	4.3	28.0	-22 72	3.0	10.4	5.5	DEC 1
DEC 11	30	14.0	7.7	15.5	26.9 62	1.4 78	34 62	26.0	5.4	28.0	-23 64	2.3	11.1	3.0	DEC 11
DEC 21	30	12.6	7.2	11.0	29.5 80	2.5 78	40 55	26.1	6.8	25.0	-27 78	-1.2	10.7	0.0	DEC 21
MONTH															MONTH
JAN	30	9.4	8.1	9.0	25.7 53	-8.3 79	39 66	29.5	6.1	31.5	-34 79	-15.3	11.4	-1.0	JAN
FEB	30	16.6	6.1	17.5	24.5 63	3.7 56	38 70	32.1	3.2	32.0	-35 56	-3.7	12.4	-0.5	FEB
MAR	30	22.6	3.7	23.0	27.7 68	12.5 52	44 66	35.3	3.7	35.0	-20 60	6.5	8.7	8.0	MAR
APR	30	30.3	1.9	30.0	35.2 78	27.3 70	49 80	43.0	3.0	43.0	12 59	18.1	3.3	18.0	APR
MAY	30	38.1	2.0	38.0	41.9 57	34.5 53	56 80	50.1	2.9	50.0	19 72	26.0	3.5	26.0	MAY
JUN	30	44.7	2.3	44.0	49.9 77	40.0 54	62 66	54.5	3.5	54.0	25 54	33.4	3.7	34.0	JUN
JUL	30	49.1	2.2	48.5	54.8 75	44.2 59	67 78	60.1	2.6	60.0	26 55	38.8	4.2	39.0	JUL
AUG	30	47.0	2.3	47.0	51.2 72	42.1 59	70 69	58.8	3.6	58.5	28 60	36.9	3.7	37.0	AUG
SEP	30	38.8	2.5	37.0	44.5 63	34.7 56	60 78	52.1	3.9	51.0	18 65	27.1	4.1	27.0	SEP
OCT	30	29.5	2.6	28.5	36.0 63	24.7 52	53 75	44.0	4.5	43.5	3 71	16.7	4.4	17.5	OCT
NOV	30	21.3	3.8	21.5	26.8 73	11.2 52	43 76	36.1	3.6	36.0	-12 52	3.4	6.9	4.5	NOV
DEC	30	14.1	5.1	13.0	22.5 80	3.8 78	40 55	31.3	3.5	31.0	-27 78	-6.8	9.3	-1.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 108395 SHOUP 1966-1981

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	16	26.0	8.9	28.0	38.4 66	8.2 79	46 66	35.6	7.8	37.5	-5 79	15.3	10.3	15.5	JAN 1
JAN 11	16	34.0	3.1	33.5	39.7 67	25.9 79	47 75	41.8	3.2	41.0	11 74	23.8	6.5	24.5	JAN 11
JAN 21	16	32.0	6.3	32.5	40.5 71	18.3 79	54 71	41.3	6.2	41.0	6 80	22.1	8.9	24.5	JAN 21
FEB 1	16	36.1	4.4	36.0	41.5 67	28.5 72	50 67	44.8	2.8	44.5	10 79	27.6	8.7	31.0	FEB 1
FEB 11	16	40.5	3.8	38.0	48.8 77	36.8 75	56 70	48.6	4.9	47.0	25 72	33.3	5.6	31.5	FEB 11
FEB 21	16	44.3	3.7	44.0	49.3 70	39.1 75	58 80	50.8	3.8	50.0	31 75	38.2	4.2	38.0	FEB 21
MAR 1	16	46.0	5.4	44.0	56.1 81	38.8 76	64 80	54.9	5.5	54.5	29 76	38.5	6.6	37.0	MAR 1
MAR 11	16	50.3	3.2	50.0	55.8 81	45.5 77	69 78	59.5	4.4	57.5	37 69	42.0	3.0	42.5	MAR 11
MAR 21	16	54.2	6.1	52.5	66.7 78 M	43.1 75	77 66	64.4	6.2	64.0	31 75	43.7	6.6	45.0	MAR 21
APR 1	16	58.1	5.4	58.0	68.0 66	48.1 75	83 77	67.9	7.8	69.5	38 75	48.1	5.7	47.5	APR 1
APR 11	16	59.3	5.3	58.0	71.7 80	50.7 70	84 80	69.8	6.2	70.0	42 79	48.7	5.0	48.0	APR 11
APR 21	16	63.4	7.0	63.0	78.9 77	52.8 70	86 77	73.8	8.8	74.5	42 67	51.8	6.8	50.5	APR 21
MAY 1	16	68.4	5.8	66.0	82.5 66	59.1 75	92 66	78.2	5.5	78.5	45 75	56.8	7.1	55.5	MAY 1
MAY 11	16	70.1	6.2	70.0	81.4 73	56.2 74	88 73	81.1	6.1	82.5	48 77	57.7	7.0	57.5	MAY 11
MAY 21	16	73.0	4.8	72.0	81.3 66	65.6 80	93 66	84.9	4.2	85.0	52 80	60.6	4.9	60.0	MAY 21
JUN 1	16	76.9	4.9	76.0	85.5 77	70.6 67	97 77	86.0	5.9	86.0	57 71	64.7	5.4	63.0	JUN 1
JUN 11	16	77.8	6.0	78.0	94.3 74	67.6 81	99 74	87.6	5.5	87.0	55 75	65.1	6.8	64.5	JUN 11
JUN 21	16	82.1	5.7	81.5	90.0 74	67.7 69	98 70	92.1	4.2	92.5	59 69	69.5	7.4	67.5	JUN 21
JUL 1	15	86.2	5.1	88.0	92.9 68	76.5 78	99 73	93.4	4.2	94.0	65 78	75.7	6.8	78.0	JUL 1
JUL 11	15	89.4	3.1	89.0	95.5 66	84.4 72	101 67	96.1	3.0	96.0	65 72	80.4	6.7	81.0	JUL 11
JUL 21	15	91.0	2.7	91.0	94.5 66	85.5 70	101 66	96.9	2.6	97.0	70 73	83.3	7.1	86.0	JUL 21
AUG 1	16	90.0	4.2	91.0	95.6 79	80.6 76	100 70	96.3	2.8	97.0	70 74	82.2	6.2	83.0	AUG 1
AUG 11	16	86.5	7.2	87.5	96.2 67	72.5 68	100 81	94.3	4.0	95.0	58 74	75.6	11.9	79.0	AUG 11
AUG 21	16	84.3	5.7	83.0	92.7 69	75.5 77	100 69	91.9	4.6	91.5	63 75	74.3	6.4	74.5	AUG 21
SEP 1	16	82.0	4.7	81.0	88.6 67	73.1 70	98 67	90.3	3.8	90.0	58 73	71.4	7.1	72.5	SEP 1
SEP 11	16	74.2	6.3	73.0	90.4 81	62.9 78	94 81	84.1	4.4	84.0	49 78	62.2	8.5	62.0	SEP 11
SEP 21	16	70.9	7.3	70.0	83.0 67	60.7 72	88 79	78.4	6.5	77.5	48 68	61.3	9.7	62.5	SEP 21
OCT 1	16	65.6	5.3	65.0	76.7 79	58.4 69	81 79	73.4	3.9	73.5	48 70	56.8	7.3	54.0	OCT 1
OCT 11	16	60.2	4.6	59.5	68.1 78	50.4 69	76 71	68.4	4.6	69.0	43 69	52.1	6.0	50.5	OCT 11
OCT 21	16	52.9	3.8	52.5	58.1 77	45.5 70 M	70 78	62.3	3.7	62.0	31 71	44.3	5.6	44.5	OCT 21
NOV 1	16	47.0	2.9	46.5	53.1 81	41.3 73	64 78	54.2	4.0	54.0	33 78	40.0	4.4	41.0	NOV 1
NOV 11	16	42.2	3.8	43.0	47.8 66	35.8 78	58 74	50.0	4.9	49.0	20 77	34.8	5.6	34.5	NOV 11
NOV 21	16	36.0	3.2	35.5	41.4 66	30.4 79	54 74	45.3	4.5	46.0	14 75	27.9	5.7	29.5	NOV 21
DEC 1	16	33.4	5.3	34.0	41.1 79	18.7 72	50 79	42.1	4.6	41.5	3 72	24.9	9.5	28.5	DEC 1
DEC 11	16	31.6	5.0	33.0	38.9 79	22.1 67	46 79	38.5	3.6	39.0	8 72	23.6	7.5	24.0	DEC 11
DEC 21	16	30.7	4.1	29.0	37.9 80	23.5 78	46 78	39.3	2.6	39.0	-6 78	20.7	9.4	21.5	DEC 21
MONTH															MONTH
JAN	16	30.7	4.7	30.5	37.5 67	17.5 79	54 71	44.1	4.3	45.5	-5 79	13.1	9.5	10.0	JAN
FEB	16	40.1	2.9	40.0	45.4 70	35.4 72	58 80	52.3	3.7	52.5	10 79	26.5	8.1	29.5	FEB
MAR	16	50.3	3.4	49.0	56.4 68	45.7 76	77 66	65.6	5.2	65.0	29 76	36.4	5.1	35.5	MAR
APR	16	60.3	4.1	59.5	68.4 77	53.1 75	86 77	76.0	6.4	75.5	38 75	44.6	3.4	44.0	APR
MAY	16	70.6	3.9	70.0	77.5 66	65.4 78	93 66	85.9	3.6	86.0	45 75	53.3	5.4	52.0	MAY
JUN	16	78.9	3.2	77.5	86.2 74	74.7 75	99 74	93.4	3.8	94.0	55 75	61.1	3.5	60.5	JUN
JUL	15	88.9	2.4	88.0	92.7 66	85.0 72	101 67	98.4	1.8	99.0	65 78	73.5	6.4	75.0	JUL
AUG	16	86.8	4.6	87.0	93.4 67	79.9 76	100 81	96.7	3.0	97.0	58 74	70.7	8.9	71.0	AUG
SEP	16	75.7	4.6	74.5	84.0 79	68.6 70	98 67	90.3	3.8	90.0	48 68	57.1	6.9	56.5	SEP
OCT	16	59.3	2.9	59.0	65.1 78	54.4 69	81 79	73.5	3.7	73.5	31 71	43.4	4.9	43.5	OCT
NOV	16	41.8	1.8	41.0	45.2 66	39.3 77	64 78	55.2	3.9	55.0	14 75	27.4	5.3	29.0	NOV
DEC	16	31.9	3.3	32.0	38.3 79	26.3 78	50 79	43.5	3.4	43.5	-6 78	17.3	9.4	19.5	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 108395 SHOUP — 1966-1981

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	16	11.8	11.0	13.5	26.0 81	-8.9 79	33 69	23.6	9.1	25.0	-23 79	-0.7	12.2	-0.5	JAN 1
JAN 11	16	20.8	4.8	21.0	28.9 67	9.8 79	34 67	29.8	4.5	31.5	-8 77	6.4	9.3	4.5	JAN 11
JAN 21	16	16.1	9.3	14.0	28.1 71	-5.0 79	36 71	27.5	7.6	30.5	-21 79	3.8	11.0	5.0	JAN 21
FEB 1	16	17.5	6.7	17.5	28.4 78	5.6 76	33 78	28.1	4.4	28.5	-12 79	6.1	10.2	8.5	FEB 1
FEB 11	16	22.6	3.5	22.5	28.2 70	17.0 73	35 70	31.4	2.0	32.0	5 72	12.3	5.4	10.0	FEB 11
FEB 21	16	23.8	4.0	23.5	29.8 68	15.6 75	37 68	31.2	2.5	32.0	7 75	16.7	5.8	17.5	FEB 21
MAR 1	16	24.9	4.5	25.0	32.1 80	14.0 76	39 80	32.8	3.0	33.0	8 76	16.3	7.1	17.5	MAR 1
MAR 11	16	27.0	2.4	26.5	32.0 72	21.4 69	36 70	33.4	1.8	33.0	7 69	20.0	5.3	22.0	MAR 11
MAR 21	16	28.9	2.4	28.5	34.3 78 M	24.3 75	40 78	35.2	2.9	36.0	7 75	22.1	4.8	23.0	MAR 21
APR 1	16	31.0	2.2	30.5	35.4 78	27.2 81	45 77	38.8	3.3	39.5	17 75	24.3	3.4	24.5	APR 1
APR 11	16	32.2	1.9	32.0	34.4 69	28.3 70	50 81	40.2	3.7	40.0	20 66	25.3	2.8	25.0	APR 11
APR 21	16	35.6	2.9	34.5	41.2 81	31.9 75	47 77	42.2	3.3	42.5	24 68	30.3	3.9	30.0	APR 21
MAY 1	16	38.0	2.5	38.0	44.0 80	34.6 69	50 80	45.0	3.2	45.0	24 72	30.3	3.5	29.5	MAY 1
MAY 11	16	38.5	2.0	38.0	41.9 69	33.6 74	51 70	45.3	3.5	45.0	27 74	32.0	2.8	32.0	MAY 11
MAY 21	16	41.0	1.8	40.5	44.9 81	37.7 75	53 66	48.4	2.6	48.5	29 75	33.5	3.0	33.0	MAY 21
JUN 1	16	44.3	3.2	43.0	51.6 77	39.5 79	65 77	51.1	4.8	50.0	32 73	37.3	3.2	38.0	JUN 1
JUN 11	16	45.4	1.9	45.0	49.0 77	41.8 78	56 69	51.8	2.6	52.0	33 73	38.5	2.8	38.5	JUN 11
JUN 21	16	47.6	3.0	47.0	53.4 73	42.6 75	60 73	53.6	3.0	53.5	34 75	40.8	3.8	41.5	JUN 21
JUL 1	15	49.6	2.3	50.0	53.0 75	44.6 71	61 70	56.5	2.5	57.0	37 71	43.6	3.6	43.0	JUL 1
JUL 11	15	51.9	2.0	51.0	55.7 75	48.0 80	63 72	58.7	3.0	58.0	42 74	46.6	2.9	46.0	JUL 11
JUL 21	15	52.4	1.2	52.0	54.5 80	49.7 72	70 66	60.0	3.9	59.0	42 73	47.1	3.0	47.0	JUL 21
AUG 1	16	51.4	1.9	50.5	53.9 68	47.7 75	63 70	57.2	3.6	57.0	40 80	46.3	2.8	46.5	AUG 1
AUG 11	16	50.1	2.0	50.0	53.3 79	46.1 78	58 79	55.2	1.5	55.0	39 78	45.3	3.3	46.0	AUG 11
AUG 21	16	47.9	2.0	48.0	50.6 67	44.1 68	63 69	54.6	4.1	54.0	37 76	41.9	3.1	41.0	AUG 21
SEP 1	16	45.1	2.7	44.0	50.9 67	41.7 76	60 67	51.8	3.7	51.5	33 76	38.7	3.1	37.5	SEP 1
SEP 11	16	42.2	3.2	42.5	47.0 66	36.0 71	55 70	49.2	3.3	50.0	28 71	35.3	4.4	35.5	SEP 11
SEP 21	16	39.3	3.4	38.5	44.8 67	33.3 72	52 76	45.9	4.1	47.0	27 72	33.7	4.3	33.5	SEP 21
OCT 1	16	35.4	1.9	35.0	38.6 76	32.8 73	52 75	43.4	3.6	42.5	25 74	28.9	2.8	29.0	OCT 1
OCT 11	16	33.3	3.7	33.5	39.0 79	24.7 69	48 79	41.9	4.7	44.0	18 69	27.6	3.9	28.0	OCT 11
OCT 21	16	30.7	2.6	31.0	34.5 77	26.9 78	45 81	39.3	2.9	38.0	6 71	23.1	5.8	24.0	OCT 21
NOV 1	16	28.9	3.1	29.0	34.7 76	21.7 71	43 76	36.5	4.0	37.5	12 71	21.9	5.1	22.5	NOV 1
NOV 11	16	26.8	4.5	27.5	33.8 67	19.4 78	41 67	34.9	3.7	35.0	2 77	17.8	6.1	19.5	NOV 11
NOV 21	16	22.5	4.3	23.5	28.2 71	13.4 79	36 67	30.5	3.9	31.5	-3 79	11.8	7.5	12.5	NOV 21
DEC 1	16	20.5	6.5	22.0	27.6 79	2.7 72	34 79	29.5	3.4	30.5	-13 72	8.8	9.5	12.0	DEC 1
DEC 11	16	18.4	6.7	20.0	28.3 69	7.5 78	34 69	27.7	4.2	28.5	-8 72	8.7	8.7	10.0	DEC 11
DEC 21	16	18.1	6.4	16.5	30.0 80	6.9 78	32 80	28.9	3.2	30.0	-20 78	5.3	10.4	6.0	DEC 21
MONTH															MONTH
JAN	16	16.2	6.4	16.5	25.8 67	-1.5 79	36 71	31.7	3.3	33.0	-23 79	-4.8	9.8	-1.0	JAN
FEB	16	21.2	3.2	21.5	26.1 78	16.5 75	37 68	32.6	1.8	33.0	-12 79	4.4	8.5	7.5	FEB
MAR	16	27.0	2.2	27.0	29.7 80	22.0 69	40 78	35.8	2.5	36.0	4 76	13.9	6.0	13.0	MAR
APR	16	33.0	1.5	32.5	35.8 78	30.2 75	50 81	42.9	3.2	43.0	17 75	23.2	2.9	23.0	APR
MAY	16	39.2	1.0	39.0	41.6 80	37.4 74	53 66	49.3	2.0	49.5	24 72	29.1	2.3	29.0	MAY
JUN	16	45.8	1.9	45.0	50.1 77	42.8 78	65 77	54.8	4.1	55.5	32 73	36.1	2.5	36.5	JUN
JUL	15	51.3	1.2	51.0	54.0 75	49.3 71	70 66	61.8	2.8	61.0	37 71	42.9	2.9	42.0	JUL
AUG	16	49.7	1.3	49.5	51.1 79	47.1 80	63 70	58.9	2.8	59.0	37 76	41.4	2.9	40.5	AUG
SEP	16	42.2	2.2	42.0	46.1 66	38.5 71	60 67	52.4	3.5	52.0	27 72	32.2	3.1	33.0	SEP
OCT	16	33.1	1.5	32.0	35.6 79	30.7 69	52 75	45.1	3.0	45.0	6 71	21.8	5.3	23.0	OCT
NOV	16	26.1	2.5	26.0	29.0 73	20.4 79	43 76	37.8	2.9	38.0	-3 79	10.4	6.4	11.5	NOV
DEC	16	19.0	4.6	19.0	25.5 79	8.7 78	34 79	31.3	2.2	32.0	-20 78	1.2	8.9	4.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 109560 WARREN — 1960-1981

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	22	28.8	5.8	28.0	37.3 61	14.1 74	47 61	36.8	6.2	38.0	6 79	18.3	6.4	19.5	JAN 1
JAN 11	22	33.7	5.1	34.0	40.6 61	22.6 62	50 68	41.1	5.5	40.5	5 63	24.5	7.2	26.0	JAN 11
JAN 21	22	33.4	4.5	33.0	40.7 60	25.7 69	54 81	42.3	5.4	41.0	8 80	23.5	6.7	22.5	JAN 21
FEB 1	22	38.5	4.7	38.0	49.7 63	31.3 79	58 63	46.2	4.9	45.0	18 76	29.0	6.9	29.5	FEB 1
FEB 11	22	37.8	4.1	37.5	50.3 77	31.6 66	57 77	45.7	4.8	45.0	20 66	31.0	5.5	31.0	FEB 11
FEB 21	22	39.1	7.0	38.5	48.0 73	21.5 62	56 68	46.9	6.0	48.0	7 62	30.5	8.1	31.0	FEB 21
MAR 1	22	38.8	4.8	38.0	47.8 81	31.7 64	60 72	47.3	5.3	46.0	20 62	30.0	6.4	29.5	MAR 1
MAR 11	22	41.3	4.6	40.0	50.1 79	33.7 71	65 60	50.5	5.6	49.0	22 65	31.4	4.5	30.5	MAR 11
MAR 21	22	43.8	5.7	42.0	56.5 78	33.8 75	68 68	54.5	7.1	53.0	22 75	32.9	5.3	34.0	MAR 21
APR 1	22	45.9	5.3	45.0	57.4 60	35.5 75	65 60	54.3	6.4	53.5	29 75	36.6	4.1	37.0	APR 1
APR 11	22	47.3	5.7	45.0	61.6 62	38.7 70	70 62	57.2	6.2	57.5	30 76	37.5	5.3	37.0	APR 11
APR 21	22	50.5	6.4	50.0	68.3 77	39.9 70	75 77	60.7	7.7	61.0	32 75	39.3	6.2	38.0	APR 21
MAY 1	21	54.6	6.4	53.0	71.7 66	44.1 64	79 66	65.7	5.6	65.0	32 65	43.0	6.7	42.0	MAY 1
MAY 11	22	58.0	6.4	57.0	70.1 73	44.5 74	78 73	69.0	6.3	70.5	37 74	46.0	7.1	44.5	MAY 11
MAY 21	21	60.9	5.1	60.0	70.2 66	54.2 78	81 72	72.3	5.2	73.0	37 80	48.0	6.4	48.0	MAY 21
JUN 1	21	65.3	6.0	65.0	75.1 77	54.9 63	85 77	73.4	6.3	74.0	44 62	54.9	7.6	52.0	JUN 1
JUN 11	22	67.0	6.4	67.0	83.9 74	56.3 64	87 74	77.4	5.5	77.5	40 76	55.0	8.8	54.0	JUN 11
JUN 21	22	70.4	6.4	69.5	80.0 61	54.6 69	86 70	79.6	4.8	80.0	45 64	57.3	8.4	54.5	JUN 21
JUL 1	22	75.7	4.3	76.0	83.6 75	67.6 78	91 73	83.0	4.2	82.0	57 74	66.3	5.7	66.5	JUL 1
JUL 11	22	77.6	3.6	77.5	86.4 60	71.1 63	93 60	84.4	3.7	85.0	57 74	68.2	6.2	68.0	JUL 11
JUL 21	22	79.6	2.6	79.0	84.3 60	75.2 70	91 80	85.7	3.1	85.5	52 72	71.8	7.3	73.5	JUL 21
AUG 1	22	79.2	4.0	79.5	85.7 61	69.5 76	94 61	85.1	4.0	86.0	58 76	72.4	5.9	74.0	AUG 1
AUG 11	22	76.4	6.3	78.0	85.6 67	64.2 76	88 61	83.1	4.0	85.0	49 68	66.7	9.7	69.0	AUG 11
AUG 21	22	72.5	6.2	71.0	81.9 69	63.4 60	92 69	80.9	5.2	79.5	45 60	62.1	9.0	61.5	AUG 21
SEP 1	22	71.3	5.0	72.0	78.8 67	60.1 64	85 67	79.6	4.5	80.0	39 64	59.5	7.7	58.5	SEP 1
SEP 11	22	65.5	6.7	65.5	79.5 81	50.4 65	87 81	75.7	6.2	77.0	36 65	51.6	7.1	52.0	SEP 11
SEP 21	22	64.6	7.8	65.0	78.1 67	50.4 61	83 67	74.1	6.3	75.0	37 68	51.2	9.6	50.5	SEP 21
OCT 1	22	61.5	6.6	62.0	74.1 80	51.9 69	79 80	72.1	5.5	72.0	37 69	49.0	9.2	49.0	OCT 1
OCT 11	22	56.4	6.3	56.5	66.8 78	45.0 69	76 71	67.1	5.9	66.5	33 66	45.0	8.1	43.5	OCT 11
OCT 21	22	50.4	6.3	49.5	64.8 62	40.5 61	72 62	60.7	5.6	59.5	29 71	39.3	6.7	38.5	OCT 21
NOV 1	22	45.6	5.5	44.0	56.6 81	37.6 77	66 76	55.8	6.3	55.0	23 78	35.8	6.1	37.0	NOV 1
NOV 11	22	39.7	4.1	38.0	48.2 67	33.2 78	57 77	48.6	5.1	48.0	15 77	31.0	6.4	31.0	NOV 11
NOV 21	22	35.8	2.8	36.0	40.7 69	30.2 75	50 76	43.5	3.4	44.0	16 75	27.3	4.9	28.0	NOV 21
DEC 1	22	33.9	5.7	34.0	44.4 65	19.9 72	50 65	42.7	4.4	43.5	6 72	24.6	8.9	26.5	DEC 1
DEC 11	22	32.3	5.5	32.0	40.9 62	19.8 67	55 79	40.8	5.7	41.5	-5 64	22.6	9.3	23.5	DEC 11
DEC 21	22	31.2	4.1	31.0	39.4 80	22.2 78	46 80	39.9	3.9	40.5	1 78	21.9	7.1	22.5	DEC 21
MONTH															MONTH
JAN	22	32.0	3.1	31.0	38.8 61	26.3 79	54 81	44.8	4.1	45.0	5 63	15.9	6.2	16.5	JAN
FEB	22	38.4	3.5	37.0	45.2 63	33.2 60	58 63	50.5	4.6	49.0	7 62	24.4	6.8	25.5	FEB
MAR	22	41.4	3.3	40.0	47.7 78	35.9 71	68 68	55.7	6.2	55.0	20 62	26.9	4.1	27.0	MAR
APR	22	47.9	3.9	47.0	57.0 77	40.9 75	75 77	62.5	6.3	62.0	29 75	33.6	2.7	33.0	APR
MAY	21	57.7	3.7	57.0	65.6 66	52.7 77	81 72	73.6	4.6	74.0	32 65	40.3	4.7	40.0	MAY
JUN	21	67.6	3.9	66.0	76.6 61	62.2 75	87 74	81.7	3.2	82.0	40 76	49.7	6.0	48.0	JUN
JUL	22	77.7	2.2	77.0	82.8 60	74.6 72	93 60	87.3	2.7	87.5	52 72	62.6	4.9	62.5	JUL
AUG	22	75.9	4.4	75.0	82.6 67	69.5 76	94 61	86.3	3.1	86.0	45 60	60.0	8.9	58.5	AUG
SEP	22	67.1	4.8	68.0	74.6 67	57.8 65	87 81	80.4	4.0	80.5	36 65	46.9	7.4	47.0	SEP
OCT	22	56.0	3.5	55.5	63.5 78	49.4 69	79 80	73.3	3.9	73.5	29 71	37.5	4.7	37.5	OCT
NOV	22	40.4	2.9	39.0	47.5 76	35.4 73	66 76	56.7	5.7	57.0	15 77	26.0	4.6	28.0	NOV
DEC	22	32.4	3.4	32.5	37.6 62	25.1 78	55 79	44.6	4.0	45.0	-5 64	16.7	8.5	20.0	DEC

(con.)

Table 21 (Con.)

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 109560 WARREN 1960-1981

		10-DAY AND MONTHLY PERIOD MEANS					I	10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	I	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	22	2.9	8.8	4.0	16.5 69	-21.3 74	I	31 69	21.9	8.4	24.0	-44 79	-17.8	11.4	-1.0	JAN 1
JAN 11	22	9.2	9.2	11.0	20.6 70	-10.8 63	I	33 74	25.4	6.5	26.5	-38 63	-12.6	9.8	-1.0	JAN 11
JAN 21	22	4.9	8.6	3.0	18.5 74	-10.5 79	I	33 71	23.3	7.6	25.0	-37 62	-15.6	11.7	-1.0	JAN 21
FEB 1	22	8.6	7.1	8.0	21.0 61	-8.0 76	I	33 61	24.2	6.2	25.0	-30 79	-9.5	10.6	-1.0	FEB 1
FEB 11	22	12.3	6.2	14.5	21.4 81	0.2 66	I	33 70	25.9	5.2	26.0	-31 65	-5.8	10.8	-1.0	FEB 11
FEB 21	22	7.9	8.6	9.0	17.8 72	-11.6 62	I	33 72	22.2	7.0	23.5	-39 62	-6.8	11.9	-1.0	FEB 21
MAR 1	22	9.0	6.7	10.0	18.2 75	-7.3 65	I	31 79	24.0	5.3	25.0	-25 66	-8.6	10.2	-1.0	MAR 1
MAR 11	21	10.3	7.2	10.0	23.0 72	-8.2 65	I	32 61	24.6	5.8	25.0	-31 65	-7.2	10.8	-1.0	MAR 11
MAR 21	22	14.0	6.1	14.0	23.2 78	3.5 65	I	32 74	26.8	4.6	27.5	-26 65	-0.4	11.5	0.5	MAR 21
APR 1	22	17.8	3.6	17.0	24.4 69	8.5 75	I	34 61	28.5	2.8	28.0	-9 75	6.0	6.7	6.0	APR 1
APR 11	22	18.0	3.6	18.5	23.4 69	10.3 64	I	35 81	28.3	3.3	29.0	-6 66	5.8	5.6	5.0	APR 11
APR 21	22	22.5	3.5	22.0	30.8 81	16.5 66	I	36 81	29.5	2.8	29.0	0 67	14.6	6.0	16.0	APR 21
MAY 1	21	25.5	3.4	26.0	32.4 80	18.8 65	I	39 80	32.5	2.9	33.0	2 67	17.4	6.0	20.0	MAY 1
MAY 11	22	26.4	3.2	27.0	30.5 81	18.4 66	I	38 81	33.0	3.6	33.5	13 74	19.8	4.0	21.0	MAY 11
MAY 21	21	28.7	2.5	28.0	35.5 81	25.4 60	I	42 81	36.7	3.1	36.0	11 60	21.3	4.1	22.0	MAY 21
JUN 1	21	31.6	3.8	30.0	39.8 77	25.1 65	I	59 77	38.8	6.1	39.0	17 66	24.7	3.3	25.0	JUN 1
JUN 11	22	33.6	2.0	33.0	36.8 74	30.0 79	I	46 81	41.4	2.7	41.0	21 73	26.5	2.9	27.0	JUN 11
JUN 21	22	33.6	3.0	33.0	41.5 73	29.3 65	I	50 73	40.9	3.8	40.0	21 76	26.5	3.5	27.0	JUN 21
JUL 1	22	34.9	3.3	33.5	41.8 75	29.2 62	I	52 81	42.5	4.6	42.0	22 71	27.8	4.1	27.0	JUL 1
JUL 11	22	35.5	3.7	35.0	46.4 75	28.4 62	I	55 75	43.0	5.2	42.5	22 62	29.0	3.4	29.0	JUL 11
JUL 21	22	36.0	3.0	36.0	41.5 75	29.5 63	I	51 76	45.1	4.9	45.5	24 69	29.4	3.2	30.0	JUL 21
AUG 1	22	34.8	2.3	34.5	39.4 71	30.3 69	I	52 76	43.8	4.5	44.5	23 69	28.7	2.5	28.5	AUG 1
AUG 11	22	34.5	2.6	34.0	39.1 79	30.7 66	I	54 61	42.6	4.8	42.5	23 66	28.2	3.0	27.5	AUG 11
AUG 21	22	31.9	2.7	31.5	37.3 61	27.8 62	I	47 66	40.9	3.0	40.5	16 65	25.0	3.5	25.0	AUG 21
SEP 1	22	30.2	3.8	29.0	38.8 78	23.2 65	I	49 78	38.8	5.9	37.5	16 65	22.7	3.3	23.5	SEP 1
SEP 11	22	26.4	4.4	28.5	34.9 66	19.6 65	I	48 81	38.0	4.9	37.5	5 65	20.7	5.9	21.5	SEP 11
SEP 21	22	27.2	3.2	26.5	32.0 66	21.2 61	I	45 76	34.9	5.1	35.5	14 71	20.6	4.1	20.5	SEP 21
OCT 1	22	24.6	3.1	24.0	32.2 63	20.1 68	I	42 75	32.8	4.3	32.0	8 68	17.3	4.3	17.5	OCT 1
OCT 11	22	22.9	3.7	23.0	28.3 75 M	12.6 69	I	42 63	32.6	4.1	32.5	1 69	15.0	6.0	15.0	OCT 11
OCT 21	22	20.7	4.0	21.0	27.4 77	13.3 70	I	35 63	29.7	3.3	30.5	-12 71	9.3	8.0	12.5	OCT 21
NOV 1	22	19.4	4.2	18.5	30.0 80	10.6 71	I	36 80	30.1	3.5	30.0	-8 78	7.3	8.8	6.5	NOV 1
NOV 11	22	17.0	6.7	19.0	25.5 81	2.2 64	I	35 73	28.4	4.1	29.0	-15 64	1.7	9.6	3.5	NOV 11
NOV 21	22	11.9	4.2	12.0	19.7 71	1.2 79	I	33 73	27.4	4.4	28.0	-19 79	-4.6	8.3	-1.0	NOV 21
DEC 1	22	10.6	8.1	11.5	23.6 75	-12.7 72	I	33 75	26.3	4.9	26.5	-37 72	-8.0	13.0	-1.0	DEC 1
DEC 11	22	8.7	8.0	9.0	22.1 69	-8.5 67	I	32 73	24.4	6.4	25.0	-42 64	-11.6	12.8	-1.0	DEC 11
DEC 21	22	8.3	7.2	7.0	25.5 80	-8.8 78	I	32 80	23.7	4.6	22.0	-45 78	-10.7	12.2	-1.0	DEC 21
MONTH							I									MONTH
JAN	22	5.7	5.3	6.0	14.9 67	-6.7 79	I	33 74	29.0	3.5	30.0	-44 79	-25.1	9.4	-1.0	JAN
FEB	22	9.7	4.8	10.0	19.3 61	-0.7 64	I	33 72	28.4	4.3	30.0	-39 62	-16.1	11.0	-1.0	FEB
MAR	21	11.4	5.1	11.0	17.8 78	-3.7 65	I	32 74	28.8	3.6	30.0	-31 65	-13.7	9.0	-1.0	MAR
APR	22	19.4	2.5	19.0	23.3 69	15.0 66	I	36 81	30.9	2.2	31.0	-9 75	3.5	6.4	4.5	APR
MAY	21	26.9	2.4	27.0	31.2 80	21.8 66	I	42 81	37.2	2.6	38.0	2 67	15.5	5.4	15.0	MAY
JUN	21	33.0	2.0	33.0	36.9 77	28.2 65	I	59 77	44.0	4.6	43.0	17 66	23.2	2.4	24.0	JUN
JUL	22	35.5	2.8	35.0	43.2 75	31.3 62	I	55 75	48.0	3.6	49.5	22 71	26.5	3.1	26.0	JUL
AUG	22	33.7	1.8	33.5	36.2 71	30.5 64	I	54 61	46.7	3.3	46.0	16 65	24.5	2.9	25.0	AUG
SEP	22	28.6	2.9	28.5	33.0 63	21.7 65	I	49 78	41.6	4.6	41.0	5 65	18.0	4.4	18.5	SEP
OCT	22	22.7	2.4	23.0	27.0 63	17.7 78	I	42 75	35.0	3.5	35.0	-12 71	7.1	7.5	9.0	OCT
NOV	22	16.1	2.8	17.0	19.6 81	10.3 79	I	36 80	31.7	2.3	32.0	-19 79	-7.7	7.0	-1.0	NOV
DEC	22	9.2	4.7	7.0	16.9 80	-2.3 78	I	33 75	29.0	3.4	30.0	-45 78	-19.7	12.0	-1.0	DEC

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101039 CAMPBELLS FERRY 1961-1978

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	9	71.1	6.1	72.0	79.0 71	61.3 75 M	88 69	81.3	5.6	83.0	45 75	57.4	8.6	58.0	MAY 1
MAY 11	9	74.0	6.2	73.0	86.7 73	65.3 77	91 73	85.7	3.8	86.0	49 77	57.9	7.6	57.0	MAY 11
MAY 21	10	76.9	5.9	76.5	86.4 66	67.7 78	99 66	88.1	5.5	89.5	53 78	64.2	7.3	64.0	MAY 21
JUN 1	13	80.8	6.4	78.0	91.6 69	73.1 67	102 77	90.5	7.0	89.0	61 68	67.8	7.1	65.0	JUN 1
JUN 11	15	83.0	7.5	81.0	98.4 74	72.1 76 M	104 61	93.8	6.3	95.0	61 64	70.8	8.1	68.0	JUN 11
JUN 21	16	86.1	7.2	86.0	98.9 61	70.4 69	104 70	95.6	5.5	96.0	57 69	73.3	9.4	74.0	JUN 21
JUL 1	18	92.0	5.4	93.0	99.6 68	81.0 78	105 75	99.8	4.2	100.0	67 77	81.2	6.9	81.5	JUL 1
JUL 11	18	93.8	4.4	93.5	100.8 66	86.8 78	109 67	102.0	3.3	100.0	70 72	83.3	7.9	85.0	JUL 11
JUL 21	18	96.7	3.5	97.0	102.5 61	90.9 76	108 68	103.2	3.1	100.0	69 72	85.1	8.4	84.0	JUL 21
AUG 1	18	96.7	5.2	97.0	105.2 61	82.5 76	114 61	103.7	5.0	100.0	75 76	87.2	6.8	89.5	AUG 1
AUG 11	17	93.7	8.0	96.0	105.1 67	76.6 68	107 67	101.1	4.7	100.0	61 68	82.2	13.0	84.0	AUG 11
AUG 21	17	89.1	7.3	88.0	100.9 70	78.7 75	109 69	98.1	6.6	98.0	67 77	77.5	9.3	75.0	AUG 21
SEP 1	17	86.0	6.0	84.0	96.5 66	75.9 64	107 69	95.5	5.8	95.0	55 64	70.9	8.8	69.0	SEP 1
SEP 11	16	77.4	6.3	78.0	84.8 67	64.5 78 M	101 63	88.4	6.7	89.0	52 68	64.9	7.0	66.0	SEP 11
SEP 21	14	78.0	8.3	76.0	93.0 67	64.8 72	99 67	85.2	8.0	83.0	47 68	67.2	11.4	68.5	SEP 21
OCT 1	11	70.1	5.5	69.0	81.4 63	60.4 69	95 63	79.2	6.4	78.0	50 69	59.4	6.8	60.0	OCT 1
OCT 11	8	64.8	5.9	63.0	75.9 63	58.0 69	78 64	71.3	5.6	72.5	47 66	58.1	7.4	57.0	OCT 11
MONTH															MONTH
MAY	8	74.2	4.8	75.0	79.7 69	66.6 78	99 66	87.9	3.3	89.5	45 75	54.3	6.0	52.0	MAY
JUN	13	82.6	3.4	82.0	89.0 74	76.4 76 M	104 70	98.1	3.3	97.0	57 69	63.8	4.3	62.0	JUN
JUL	18	94.2	3.5	94.0	100.1 61 M	88.1 78	109 67	104.3	2.4	100.0	67 77	76.7	6.2	77.0	JUL
AUG	17	92.9	5.7	93.0	101.5 67	83.8 76	114 61	104.4	3.6	100.0	61 68	75.2	9.4	74.0	AUG
SEP	14	80.8	6.1	80.0	90.9 67	72.4 70	107 69	95.4	6.3	94.0	47 68	61.1	7.6	64.5	SEP

MINIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101039 CAMPBELLS FERRY 1961-1978

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	9	38.4	3.2	38.0	42.3 71	33.8 68	50 77	44.7	5.1	45.0	28 73	31.8	2.4	32.0	MAY 1
MAY 11	9	40.7	1.9	40.0	43.8 69	37.6 71	51 68	47.7	2.6	48.0	29 73	34.2	3.3	35.0	MAY 11
MAY 21	10	42.4	0.9	42.0	44.2 66	41.1 77	53 69	50.3	2.2	50.5	31 66	34.1	2.2	34.0	MAY 21
JUN 1	13	46.9	3.4	46.0	52.0 69	42.1 65	61 77	53.4	3.9	53.0	33 73	38.8	3.2	39.0	JUN 1
JUN 11	15	47.9	2.2	47.0	51.4 63	43.1 73	58 69	54.9	2.1	55.0	35 73	40.8	3.2	42.0	JUN 11
JUN 21	16	49.0	2.4	48.0	53.5 73	44.8 76 M	62 68	55.7	3.0	55.0	33 76	42.0	4.1	43.0	JUN 21
JUL 1	18	50.7	2.7	50.0	54.9 75	44.8 71	61 70	56.7	2.4	56.5	36 71	43.2	3.6	43.0	JUL 1
JUL 11	18	52.7	2.5	52.0	58.6 75	48.3 62	67 75	59.7	3.0	59.0	41 63	46.3	3.3	45.5	JUL 11
JUL 21	18	52.8	1.9	53.0	55.1 75	46.2 63	65 78	59.9	2.5	60.0	40 63	47.1	3.1	46.5	JUL 21
AUG 1	18	53.3	2.0	53.0	56.2 71	48.9 75	65 74	60.3	3.4	62.0	43 75	47.4	3.0	47.5	AUG 1
AUG 11	17	52.1	1.9	52.0	55.4 72	48.2 74	64 69	58.7	2.8	58.0	41 76	46.3	3.1	46.0	AUG 11
AUG 21	17	49.4	1.6	49.0	52.0 67	46.2 68	62 69	57.2	3.1	58.0	36 65	42.5	3.3	42.0	AUG 21
SEP 1	17	46.5	3.7	45.0	53.5 63	42.0 71	64 63	53.4	5.0	53.0	33 71	39.2	4.1	39.0	SEP 1
SEP 11	16	43.1	4.1	43.5	50.2 66	36.9 70	60 63	51.1	4.5	51.0	25 65	35.4	5.5	35.0	SEP 11
SEP 21	14	41.7	4.2	39.5	47.4 66	35.3 72	56 76	48.2	4.8	48.5	28 70	35.3	4.3	36.0	SEP 21
OCT 1	11	39.1	3.6	38.0	47.2 63	34.1 68	58 66	47.9	5.1	46.0	27 68	32.7	4.4	32.0	OCT 1
OCT 11	8	35.3	4.7	35.0	42.5 63	28.5 69	58 63	47.0	6.9	46.0	23 69	28.4	4.5	28.0	OCT 11
MONTH															MONTH
MAY	8	40.7	0.6	40.0	41.2 77	39.5 68	53 69	50.6	1.7	50.5	28 73	31.4	2.2	32.0	MAY
JUN	13	47.8	1.4	48.0	50.4 77	46.0 76 M	62 68	57.4	2.8	58.0	33 76	37.6	3.0	38.0	JUN
JUL	18	52.1	1.7	52.0	56.2 75	49.0 63	67 75	61.6	2.5	61.0	36 71	42.9	3.5	42.5	JUL
AUG	17	51.4	1.1	50.0	53.1 72	50.0 78 M	65 74	61.4	2.3	62.0	36 65	41.9	2.9	42.0	AUG
SEP	14	43.7	3.2	42.5	49.0 63	38.8 71	64 63	54.4	4.4	53.0	25 65	32.9	4.1	34.0	SEP

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE — MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101032 RED RIVER RS — 1951-1980

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
MAY 11	14	66.1	6.4	64.0	77.5 73	54.7 62	86 54	77.1	5.6	78.5	42 67	51.1	8.9	47.0	MAY 11
MAY 21	16	66.7	7.1	65.5	77.7 66 M	55.4 78	92 56	78.5	6.5	80.0	39 80	52.1	9.8	48.5	MAY 21
JUN 1	23	69.4	6.4	69.0	81.9 69 M	58.6 63	90 56	79.9	6.7	80.0	47 74	57.2	7.9	55.0	JUN 1
JUN 11	23	72.2	6.1	71.0	88.9 74	62.4 54	93 74	82.7	5.2	82.0	49 57	59.8	8.1	59.0	JUN 11
JUN 21	27	74.7	5.1	74.0	82.8 61	64.3 63	94 55	85.0	5.7	85.0	48 69	62.8	6.2	63.0	JUN 21
JUL 1	29	79.9	4.3	80.0	88.7 75	72.7 77	99 73	88.7	5.2	89.0	50 55	68.4	6.1	69.0	JUL 1
JUL 11	29	82.3	4.5	81.0	91.7 60	74.7 63	99 53	90.7	3.8	90.0	61 63	72.7	7.0	72.0	JUL 11
JUL 21	29	84.3	2.9	84.0	89.1 60	78.1 70	99 59	91.5	3.1	92.0	61 75	74.8	5.5	76.0	JUL 21
AUG 1	29	83.3	3.9	83.0	90.5 61	73.6 56	103 61	91.2	4.2	91.0	59 56	74.8	6.2	76.0	AUG 1
AUG 11	28	81.2	6.3	82.5	91.9 67	68.1 68	99 61	89.4	5.3	91.0	50 78	70.8	10.7	73.0	AUG 11
AUG 21	28	76.8	5.4	75.5	87.6 70	68.3 65	100 69	87.5	5.8	88.0	51 56	65.0	7.9	64.5	AUG 21
SEP 1	27	76.1	4.8	77.0	83.9 67	64.7 64	100 69	86.0	5.7	87.0	50 64	62.1	7.5	61.0	SEP 1
SEP 11	23	70.4	6.4	70.0	83.6 53	55.7 78	92 53	81.6	6.7	82.0	45 78	56.1	6.5	57.0	SEP 11
SEP 21	18	71.4	8.1	72.0	84.4 67 M	54.1 77 M	90 63	81.2	6.1	81.0	45 77	59.3	10.6	59.5	SEP 21
MONTH															MONTH
JUN	20	71.9	3.1	72.0	79.1 74 M	67.2 63	94 55	87.9	3.9	88.5	47 74	53.4	3.9	53.0	JUN
JUL	29	82.2	2.5	82.0	88.0 60	77.7 77	99 73	93.7	3.3	93.0	50 55	65.8	5.0	66.0	JUL
AUG	28	80.3	4.0	79.5	88.3 61	74.9 75 M	103 61	93.0	3.8	93.0	50 78	62.8	8.0	62.0	AUG
SEP	18	72.6	5.3	73.0	80.6 67 M	64.9 65 M	100 69	86.4	5.8	86.5	45 78	52.3	6.0	53.0	SEP

MINIMUM DAILY TEMPERATURE

STATION NUMBER 101032 RED RIVER RS — 1951-1980

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
MAY 11	14	32.0	4.1	32.5	39.1 57	24.5 66 M	51 76	39.5	5.1	39.5	15 65	24.1	4.7	24.5	MAY 11
MAY 21	16	34.2	2.5	33.5	40.1 56 M	30.5 54	49 63	42.3	3.6	42.0	20 66	27.3	4.6	28.0	MAY 21
JUN 1	23	37.2	3.0	37.0	43.7 69 M	31.9 55 M	60 77	44.4	3.7	44.0	23 65	29.5	3.5	30.0	JUN 1
JUN 11	23	38.9	2.7	38.0	44.6 74	34.0 52 M	57 59	47.0	3.1	47.0	24 52	31.3	3.6	32.0	JUN 11
JUN 21	27	39.4	3.3	39.0	45.9 70	33.8 51 M	57 72	48.2	4.5	48.0	25 66	31.6	3.3	31.0	JUN 21
JUL 1	30	40.0	3.3	39.0	48.0 75	34.2 66	60 80	48.0	4.8	46.5	25 66	32.7	4.0	32.0	JUL 1
JUL 11	30	41.7	3.0	40.5	51.3 75	36.2 62	60 75	50.0	4.3	49.5	28 62	34.7	3.3	35.0	JUL 11
JUL 21	30	41.1	3.4	41.0	46.2 56	33.5 66	58 79	50.2	4.9	51.5	26 66	33.7	3.6	34.0	JUL 21
AUG 1	30	40.2	3.3	40.0	47.5 71	34.4 54	58 78	48.6	4.4	49.0	28 56	33.9	3.5	33.0	AUG 1
AUG 11	30	39.2	3.2	38.5	47.0 79	33.5 66	55 79	47.2	4.7	48.0	23 66	32.7	3.6	32.5	AUG 11
AUG 21	30	37.6	2.8	37.5	43.3 79	33.0 55	54 66	46.2	4.4	46.0	23 66	29.8	3.2	30.0	AUG 21
SEP 1	29	34.6	3.6	34.0	45.6 78	28.2 62	56 78	43.2	4.9	43.0	19 64	26.5	3.6	27.0	SEP 1
SEP 11	24	32.7	4.2	32.5	41.6 80	24.4 71	52 51	42.1	5.3	42.0	13 65	25.0	4.6	26.0	SEP 11
SEP 21	18	31.9	3.2	31.5	38.9 76 M	26.9 74	46 69	39.5	4.6	41.0	18 64	24.7	4.2	24.0	SEP 21
MONTH															MONTH
JUN	20	38.6	2.0	38.0	42.7 58	36.1 60	60 77	50.1	3.2	49.5	23 65	28.4	2.7	29.0	JUN
JUL	30	41.0	2.5	40.0	48.1 75	35.3 66	60 80	53.4	3.4	54.0	25 66	31.1	3.1	31.0	JUL
AUG	30	39.0	2.4	38.0	44.4 78	35.0 66	58 78	51.2	3.4	51.5	23 66	29.3	2.9	30.0	AUG
SEP	18	33.2	2.9	32.0	38.8 78 M	28.8 65 M	56 78	46.0	4.3	44.0	13 65	22.4	3.6	22.5	SEP

MAXIMUM DAILY TEMPERATURE

STATION NUMBER 101019 HELLS HALF ACRE LO — 1954-1980

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
JUL 1	18	66.9	4.6	68.0	74.0 75	59.8 78	85 73	73.9	4.1	75.0	45 78	57.8	6.9	59.5	JUL 1
JUL 11	26	70.4	4.3	70.0	80.4 60	62.0 80	86 60	77.7	3.4	78.0	46 72	61.7	6.9	61.5	JUL 11
JUL 21	26	72.2	3.1	72.0	78.0 60	65.6 77	85 60	78.8	3.1	79.0	46 72	63.1	6.9	65.0	JUL 21
AUG 1	27	71.3	4.5	72.0	78.4 61	62.1 76	86 61	78.3	4.2	79.0	49 76	62.6	6.6	63.0	AUG 1
AUG 11	26	70.2	5.9	71.5	79.3 67	58.0 78 M	84 61	77.0	4.5	78.0	42 78	60.1	9.6	62.5	AUG 11
AUG 21	24	65.5	7.2	64.0	76.9 71	53.6 65	86 69	75.4	6.0	77.0	37 60	53.0	10.7	51.0	AUG 21
MONTH															MONTH
JUL	20	70.2	3.1	70.0	76.3 60	64.8 77 M	86 60	80.1	3.1	80.0	45 78	55.2	5.8	55.5	JUL
AUG	24	68.9	5.0	67.5	77.2 71	61.0 75 M	86 69	80.0	3.6	80.0	37 60	52.5	10.2	50.0	AUG

MINIMUM DAILY TEMPERATURE

STATION NUMBER 101019 HELLS HALF ACRE LO — 1954-1980

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
JUL 1	18	43.1	4.0	42.0	51.4 75	34.9 69	61 73	51.8	3.6	51.5	20 71	33.7	4.5	33.0	JUL 1
JUL 11	26	46.0	4.6	47.0	55.7 60	36.2 68	63 60	54.9	4.6	56.0	24 68	36.2	6.4	36.0	JUL 11
JUL 21	26	47.5	3.0	47.0	52.9 60	42.2 69	62 75	55.8	3.3	56.0	26 59	37.4	6.1	37.0	JUL 21
AUG 1	27	46.8	3.8	47.0	54.6 61	39.7 69	66 61	55.6	4.1	56.0	24 69	37.4	5.1	38.0	AUG 1
AUG 11	26	45.9	5.2	45.5	57.7 67	35.3 78 M	61 71	54.1	4.0	54.0	25 64	36.4	7.2	35.5	AUG 11
AUG 21	24	42.2	5.1	41.5	54.5 70	34.1 60	67 69	53.3	6.1	54.5	23 71	32.0	6.4	30.5	AUG 21
MONTH															MONTH
JUL	20	45.9	3.0	46.0	51.6 60	38.5 69	63 60	57.4	3.2	58.0	20 71	31.9	3.6	32.0	JUL
AUG	24	44.9	3.4	43.0	51.4 67	40.3 80 M	67 69	58.6	3.3	58.0	23 71	30.5	4.8	30.0	AUG

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE — MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101801 BONANZA GS — 1969-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 11	6	68.4	4.1	68.5	73.6 82 M	61.1 73	84 70	77.2	2.5	76.5	45 73	59.8	8.2	61.0	JUN 11
JUN 21	12	72.7	6.6	74.0	79.1 79	55.1 69	89 79	80.3	4.7	80.0	44 69	61.7	10.0	66.0	JUN 21
JUL 1	15	74.3	5.2	75.0	82.4 75	65.1 82 M	91 73	81.9	4.9	81.0	52 83	63.9	6.6	65.0	JUL 1
JUL 11	15	77.8	2.6	78.0	82.7 79	72.1 83	91 79	84.7	3.9	85.0	56 83	68.4	4.6	69.0	JUL 11
JUL 21	15	80.0	2.8	79.0	83.7 78	74.4 73	91 78	85.9	3.2	86.0	54 73	71.9	7.5	75.0	JUL 21
AUG 1	15	80.4	5.1	81.0	88.6 83	70.4 76	94 83	86.1	4.1	87.0	59 74	72.8	7.1	74.0	AUG 1
AUG 11	15	77.2	5.4	77.0	85.0 77	67.7 76	89 83	84.1	4.1	85.0	56 78	67.9	8.3	70.0	AUG 11
AUG 21	14	75.5	5.0	75.0	83.4 70	67.3 75	89 70	82.8	4.2	82.0	52 75	65.4	7.3	67.0	AUG 21
SEP 1	14	74.0	4.0	75.0	79.0 77	66.8 70	87 79	81.4	3.3	82.0	44 73	63.9	8.4	66.5	SEP 1
SEP 11	13	67.9	7.2	69.0	79.4 81 M	53.5 78	85 79	77.4	5.3	78.0	41 78	54.8	8.1	53.0	SEP 11
SEP 21	10	64.5	8.5	64.0	74.1 79	51.6 72	82 79	73.8	6.8	74.0	38 81	51.7	11.4	49.0	SEP 21
MONTH															MONTH
JUL	15	77.5	1.9	77.0	81.5 79	73.8 83	91 79	87.9	2.3	88.0	52 83	61.4	5.5	61.0	JUL
AUG	14	77.6	3.8	77.0	83.0 70	71.2 75	94 83	86.9	3.5	87.5	52 75	63.0	7.7	62.0	AUG
SEP	10	69.1	4.8	68.5	77.1 79	61.2 72	87 79	82.1	3.0	82.5	38 81	48.1	10.0	46.0	SEP

MINIMUM DAILY TEMPERATURE

STATION NUMBER 101801 BONANZA GS — 1969-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 11	6	32.4	4.1	31.0	38.3 77	28.2 73	47 69	40.0	5.1	37.5	23 78	26.5	3.8	25.5	JUN 11
JUN 21	12	35.4	2.3	35.0	39.6 73	32.1 78	49 73	41.8	3.8	42.5	25 71	28.8	2.7	28.5	JUN 21
JUL 1	15	36.3	3.1	35.0	42.4 75	31.5 69	52 81	43.6	4.6	42.0	24 71	28.9	2.6	29.0	JUL 1
JUL 11	15	37.2	2.9	37.0	43.5 75	32.3 82 M	54 73	45.9	5.1	45.0	27 82	30.7	2.7	30.0	JUL 11
JUL 21	15	38.3	2.4	38.0	41.1 75	32.9 72	54 80	46.2	5.1	46.0	27 81	31.6	2.8	32.0	JUL 21
AUG 1	15	36.8	3.9	36.0	46.2 83	32.0 82	54 83	44.5	4.7	44.0	25 69	30.8	3.8	31.0	AUG 1
AUG 11	15	36.8	3.7	35.0	43.6 83	30.9 74	52 83	44.6	4.4	44.0	24 78	31.2	3.9	31.0	AUG 11
AUG 21	14	34.6	2.4	34.5	38.8 72	30.0 78	47 76	42.6	3.2	43.0	21 76	27.6	3.7	27.5	AUG 21
SEP 1	14	31.4	3.0	31.0	39.4 78	27.3 75	49 78	40.5	5.0	40.5	19 83	23.9	2.5	24.5	SEP 1
SEP 11	13	28.9	3.8	29.0	35.3 76	21.3 71	42 83	37.5	4.7	38.0	14 71	21.1	4.5	22.0	SEP 11
SEP 21	10	26.1	2.8	25.5	30.0 73	21.7 71	40 82	32.5	4.6	33.0	12 71	19.9	3.6	19.5	SEP 21
MONTH															MONTH
JUL	15	37.3	1.8	37.0	42.3 75	34.4 72	54 80	50.3	3.6	52.0	24 71	28.0	1.9	28.0	JUL
AUG	14	36.1	2.6	35.0	42.0 83	32.7 80	54 83	47.6	3.4	46.0	21 76	26.9	3.4	26.5	AUG
SEP	10	28.9	2.3	29.0	32.1 73 M	24.1 71	49 78	41.0	4.0	41.0	12 71	18.8	3.6	19.5	SEP

MAXIMUM DAILY TEMPERATURE

STATION NUMBER 101207 LANDMARK RS — 1968-1981

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 21	7	71.4	4.3	73.0	76.0 79 M	65.8 76	84 70	80.3	3.6	82.0	47 70	61.1	5.3	64.0	JUN 21
JUL 1	11	74.2	5.0	75.0	81.3 68	64.0 78 M	89 73	81.2	5.1	81.0	52 78	63.5	4.8	65.0	JUL 1
JUL 11	14	76.3	3.0	75.5	81.4 73	72.6 72	90 79	83.5	4.1	83.0	56 74	66.1	5.7	65.5	JUL 11
JUL 21	14	78.9	2.9	79.0	83.0 80	73.6 81	90 80	85.4	3.1	85.5	59 72	71.1	6.2	71.5	JUL 21
AUG 1	14	78.8	4.4	79.5	84.3 71	69.4 76	91 77	84.7	3.5	85.0	58 74	71.6	7.0	72.0	AUG 1
AUG 11	14	74.3	7.3	74.5	83.5 77	60.0 68	89 77	82.1	4.5	84.0	44 68	65.0	11.1	67.0	AUG 11
AUG 21	14	72.4	6.3	71.5	81.5 70	62.8 77	91 69	81.1	4.9	80.5	48 77	61.3	9.3	60.5	AUG 21
SEP 1	14	71.0	3.1	71.5	76.1 69	64.8 70	84 69	79.1	2.7	79.0	50 73	59.3	5.7	59.5	SEP 1
SEP 11	14	64.8	6.4	63.5	77.2 81 M	50.6 78 M	84 81	74.1	6.5	75.5	38 78	51.6	6.5	52.5	SEP 11
SEP 21	8	61.2	8.6	61.5	70.7 74	50.5 77	78 79	70.6	5.4	71.0	37 81	51.1	11.1	51.5	SEP 21
OCT 1	6	62.8	6.5	62.0	72.3 79	53.8 73 M	77 79	71.7	3.9	71.0	37 75	48.5	11.4	45.5	OCT 1
MONTH															MONTH
JUL	12	76.6	1.7	76.5	78.7 68	73.8 77	90 80	86.9	2.2	87.0	52 78	61.3	4.4	64.0	JUL
AUG	14	75.1	4.6	74.5	82.2 71	68.0 68	91 77	85.5	3.3	85.0	44 68	58.6	9.9	56.5	AUG
SEP	8	66.1	4.5	65.5	71.8 79 M	60.1 72	84 81	79.0	2.1	78.5	37 81	48.5	8.6	48.5	SEP

MINIMUM DAILY TEMPERATURE

STATION NUMBER 101207 LANDMARK RS — 1968-1981

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 21	7	31.5	3.2	31.0	36.8 73	26.3 76	48 73	42.3	4.9	43.0	17 76	24.1	3.4	25.0	JUN 21
JUL 1	11	32.6	2.9	31.0	36.3 80	27.3 73	50 70	42.2	5.1	41.0	19 73	24.6	3.3	24.0	JUL 1
JUL 11	14	32.8	2.9	32.5	38.1 75	28.0 81	51 76	41.7	5.7	41.0	19 73	26.4	3.1	26.5	JUL 11
JUL 21	14	32.8	2.6	32.5	36.0 77	26.3 81	51 79	43.9	6.3	45.0	22 70	26.9	2.4	27.0	JUL 21
AUG 1	14	30.9	3.7	30.5	37.3 71	25.0 69	52 76	42.6	7.0	44.5	19 69	24.7	2.8	25.0	AUG 1
AUG 11	14	31.5	3.4	30.0	38.7 79	26.2 70	48 79	40.6	4.4	40.5	22 70	25.8	2.4	26.0	AUG 11
AUG 21	14	29.1	2.5	28.5	34.1 79	25.0 81 M	44 69	38.4	3.8	38.5	15 69	22.3	3.9	22.5	AUG 21
SEP 1	14	26.6	4.0	25.0	35.7 78	21.8 81	50 78	36.0	7.8	34.5	11 69	18.8	3.1	19.0	SEP 1
SEP 11	14	25.3	5.5	26.0	34.3 68 M	15.3 71	48 68	36.2	7.2	39.0	6 71	16.5	4.9	16.0	SEP 11
SEP 21	8	23.1	5.4	21.5	31.0 76 M	16.6 75	44 76	30.9	7.7	32.0	7 81	16.4	5.4	15.5	SEP 21
OCT 1	6	18.7	4.5	19.0	25.7 75	13.5 73 M	40 75	28.2	6.4	26.5	2 74	11.2	5.3	13.5	OCT 1
MONTH															MONTH
JUL	12	32.4	1.5	31.5	34.8 76	29.7 81 M	51 79	47.9	2.4	48.0	19 73	23.6	2.3	23.5	JUL
AUG	14	30.5	2.2	30.0	33.5 79	26.5 69	52 76	45.6	3.8	46.0	15 69	21.5	3.3	22.0	AUG
SEP	8	24.3	3.2	23.5	29.2 76 M	20.6 71	50 78	37.9	4.8	38.5	6 71	13.6	3.7	14.0	SEP

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE — MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101303 INDIANOLA RS — 1968-1983

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	15	67.9	5.3	67.0	76.0 69 M	58.7 75	83 69	76.5	4.6	77.0	47 75	57.7	6.5	60.0	MAY 1
MAY 11	15	70.3	7.0	70.0	83.0 73	59.3 74	91 73	81.6	7.2	85.0	50 83	57.9	7.5	55.0	MAY 11
MAY 21	15	72.1	4.4	72.0	79.7 69	65.6 78	93 72	84.3	4.8	85.0	48 80	58.1	5.3	58.0	MAY 21
JUN 1	15	78.8	6.2	78.0	87.1 69	68.2 82	99 77	88.3	6.0	90.0	59 80	67.5	7.8	67.0	JUN 1
JUN 11	16	79.0	6.5	78.0	97.2 74	69.2 81	102 74	89.8	5.7	89.5	56 73	67.5	8.0	65.5	JUN 11
JUN 21	16	83.6	6.1	84.5	91.5 74	68.3 69	101 74	93.8	5.1	94.5	58 69	71.6	6.9	72.5	JUN 21
JUL 1	15	87.6	5.3	88.0	94.0 75	79.1 78	103 81	95.4	4.8	96.0	59 83	75.8	7.4	78.0	JUL 1
JUL 11	16	90.3	3.5	90.0	97.4 73	82.4 83	104 79	98.6	3.2	98.5	63 72	80.8	7.7	81.5	JUL 11
JUL 21	16	92.9	3.0	92.5	97.7 80	87.8 70	103 72	99.5	2.3	99.5	68 72	83.7	7.1	84.5	JUL 21
AUG 1	16	92.4	4.0	93.0	98.2 79	83.8 76	103 83	99.8	3.0	100.0	72 76	83.7	6.3	85.0	AUG 1
AUG 11	16	89.1	6.8	88.5	97.3 81	75.6 68	102 81	97.3	3.6	97.5	62 78	78.2	10.6	80.5	AUG 11
AUG 21	16	87.0	6.4	85.0	96.5 81	76.1 75	105 69	95.9	5.4	96.0	63 75	74.9	8.0	74.0	AUG 21
SEP 1	16	83.9	4.1	83.5	89.4 69	75.5 70	99 81	93.9	3.0	94.0	58 70	70.0	7.6	70.0	SEP 1
SEP 11	16	76.4	6.3	75.5	92.0 81	67.3 78	99 69	88.9	6.0	88.0	53 83	60.9	5.9	62.0	SEP 11
SEP 21	16	71.7	6.6	69.5	84.8 79	63.6 77	92 79	80.0	5.7	80.0	48 68	61.1	9.5	58.5	SEP 21
OCT 1	13	68.0	6.5	67.0	78.4 79	55.9 82	84 79	77.1	6.7	79.0	50 82	58.2	8.1	55.0	OCT 1
OCT 11	9	62.8	6.4	63.0	72.6 79 M	51.9 69	80 79	70.7	5.7	72.0	44 69	54.3	6.6	56.0	OCT 11
OCT 21	9	56.3	4.4	58.0	61.0 73 M	48.7 70 M	74 73	64.9	5.2	65.0	33 71	47.3	6.2	49.0	OCT 21
MONTH															MONTH
MAY	13	70.6	4.3	71.0	78.4 69 M	64.4 78	93 72	86.6	3.4	86.0	47 75	54.4	4.8	53.0	MAY
JUN	15	80.3	3.5	80.0	87.9 74	76.0 81	102 74	95.0	4.1	95.0	56 73	62.2	4.3	61.0	JUN
JUL	15	90.4	2.5	90.0	93.7 68	84.2 83 M	104 79	101.1	2.0	100.0	59 83	73.5	7.2	77.0	JUL
AUG	16	89.4	4.6	89.0	96.4 81	82.3 68	105 69	100.7	2.8	100.0	62 78	73.0	8.7	72.0	AUG
SEP	16	77.4	4.0	76.0	86.1 79	70.8 70	99 81	94.3	3.3	94.5	48 68	57.3	7.0	55.5	SEP
OCT	8	61.7	3.3	61.5	66.2 74 M	57.4 69 M	84 79	78.0	5.0	77.5	33 71	48.1	3.6	48.0	OCT

MINIMUM DAILY TEMPERATURE

STATION NUMBER 101303 INDIANOLA RS — 1968-1983

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	15	35.8	2.2	35.0	39.6 71	31.7 69 M	48 80	43.3	3.1	43.0	23 82	28.5	2.5	28.0	MAY 1
MAY 11	15	37.7	2.7	38.0	41.5 73	31.6 74	52 73	45.1	3.7	46.0	24 74	30.4	3.3	31.0	MAY 11
MAY 21	15	40.3	2.0	39.0	45.7 81	37.4 75	53 79	49.2	3.2	50.0	27 75	31.5	3.0	32.0	MAY 21
JUN 1	15	44.0	3.5	43.0	50.2 72	39.1 74	57 77	51.7	4.2	52.0	30 73	36.0	3.8	36.0	JUN 1
JUN 11	16	44.9	2.1	44.5	49.5 74	40.3 78	57 79	52.1	2.8	52.0	31 73	37.1	2.9	37.0	JUN 11
JUN 21	16	47.4	3.4	46.5	53.2 73	41.7 75	62 70	54.8	4.5	55.5	32 75	39.5	4.2	39.0	JUN 21
JUL 1	15	49.1	2.8	49.0	54.1 75	43.7 71	62 81	57.1	3.2	57.0	31 71	41.6	4.5	41.0	JUL 1
JUL 11	16	50.1	2.3	49.0	55.4 75	46.4 80 M	61 75	56.8	2.8	56.0	37 83	43.7	3.6	43.0	JUL 11
JUL 21	16	51.7	1.7	51.0	54.6 80	48.8 81	66 69	59.1	4.2	59.0	42 76	45.5	2.8	45.0	JUL 21
AUG 1	16	51.0	2.2	50.0	55.4 83	47.9 75	66 74	59.2	3.4	59.0	36 70	44.4	3.7	45.0	AUG 1
AUG 11	16	49.7	2.3	49.0	54.6 83	45.6 78	61 83	56.1	2.8	56.0	37 78	43.3	4.3	44.0	AUG 11
AUG 21	16	47.2	2.0	46.0	50.1 81	43.4 68	63 69	54.3	3.5	53.5	36 76	40.1	3.5	39.0	AUG 21
SEP 1	16	44.1	2.2	43.5	49.9 78	41.3 76	60 78	52.3	3.1	52.0	30 76	35.5	3.1	35.0	SEP 1
SEP 11	16	40.7	3.5	40.5	47.1 80	34.7 70	56 80	49.0	3.4	49.5	26 71	32.2	4.7	31.0	SEP 11
SEP 21	16	37.3	3.3	36.0	42.3 79	31.4 72	52 76	44.6	3.8	45.0	25 70	30.9	4.1	30.0	SEP 21
OCT 1	13	33.8	2.4	34.0	38.9 75	30.6 73	53 75	42.7	4.0	41.0	21 74	26.4	3.4	26.0	OCT 1
OCT 11	9	32.7	4.8	34.0	38.7 79 M	22.9 69	50 68	43.1	5.4	43.0	14 69	25.2	5.8	24.0	OCT 11
OCT 21	9	30.1	2.2	29.0	34.6 82 M	28.0 72 M	46 71	38.9	3.8	40.0	4 71	21.3	7.7	24.0	OCT 21
MONTH															MONTH
MAY	13	38.3	1.4	38.0	41.4 81 M	35.8 74	53 79	49.8	2.6	50.0	23 82	27.2	2.1	28.0	MAY
JUN	15	45.4	1.7	45.0	47.6 77	42.2 75	62 70	56.1	3.4	57.0	30 73	34.5	2.1	35.0	JUN
JUL	15	50.3	1.6	50.0	54.6 75	48.0 77	66 69	61.1	2.8	62.0	31 71	40.4	4.0	40.0	JUL
AUG	16	49.2	1.6	48.0	52.9 83	46.9 78	66 74	59.9	3.2	59.5	36 76	39.4	3.1	38.5	AUG
SEP	16	40.8	1.9	41.0	43.1 80	37.2 71	60 78	52.8	2.6	52.0	25 70	29.3	2.7	30.0	SEP
OCT	8	31.8	1.5	32.0	33.6 82 M	28.7 69	53 75	45.0	2.8	45.0	4 71	20.0	3.6	21.0	OCT

(con.)

MAXIMUM DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101206 KRASSEL RS

1968-1983

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
MAY 1	6	63.8	6.1	62.0	71.0 76 M	57.8 75	80 80	75.8	3.5	76.5	46 77	52.2	6.4	51.5	MAY 1
MAY 11	7	71.2	7.8	72.0	83.9 73	62.1 78 M	89 73	81.7	4.8	81.0	48 77	57.1	7.6	55.0	MAY 11
MAY 21	7	68.7	5.9	67.0	75.4 79	61.9 78 M	86 80	82.1	4.5	84.0	46 80	55.0	6.4	57.0	MAY 21
JUN 1	10	76.0	5.2	76.0	85.3 77	69.3 71	98 77	85.1	6.5	84.5	58 79	63.8	5.0	62.5	JUN 1
JUN 11	10	76.4	4.7	76.0	82.1 68	66.9 76 M	93 68	85.5	4.5	86.0	52 79	64.0	8.5	66.0	JUN 11
JUN 21	12	80.8	6.3	80.0	88.0 70	64.5 69	98 70	90.3	5.8	92.5	55 69	68.1	7.1	70.0	JUN 21
JUL 1	14	85.3	6.5	84.5	96.1 68	75.9 83	102 73	93.2	5.2	93.0	60 83	74.1	7.2	74.5	JUL 1
JUL 11	16	87.3	4.1	87.0	94.9 73	79.2 83	103 73	94.8	5.0	95.0	64 83	76.4	7.2	77.5	JUL 11
JUL 21	16	90.5	3.1	89.5	95.5 68	85.8 83	103 75	96.8	3.6	97.5	72 72	82.9	5.2	82.5	JUL 21
AUG 1	16	90.7	4.1	91.5	96.3 71	81.4 76	103 83	96.7	4.2	97.5	70 76	84.0	5.9	85.5	AUG 1
AUG 11	16	86.5	7.5	86.0	96.4 71	71.6 68	100 77	93.7	4.5	93.5	54 68	76.9	11.9	80.0	AUG 11
AUG 21	16	83.8	6.8	82.5	94.1 70	73.0 77	103 69	92.3	6.0	92.5	59 77	72.9	8.5	71.0	AUG 21
SEP 1	16	81.5	3.4	81.5	87.2 69	75.5 70	97 73	90.9	3.4	91.0	57 70	68.8	6.8	67.5	SEP 1
SEP 11	15	74.1	7.3	73.0	88.3 81 M	59.2 78 M	95 81	84.7	6.9	85.0	43 78	60.1	8.0	60.0	SEP 11
SEP 21	12	70.9	6.3	69.0	81.4 74 M	62.4 81	87 74	80.5	3.9	81.0	44 68	61.5	8.7	62.0	SEP 21
OCT 1	6	69.8	8.3	68.5	80.0 79	58.4 81 M	84 79	79.7	4.2	81.0	45 81	58.5	12.5	56.0	OCT 1
MONTH															MONTH
MAY	6	68.9	4.8	67.5	74.5 73	62.6 77 M	89 73	85.7	1.8	85.0	46 80	50.7	6.6	47.0	MAY
JUN	7	77.5	3.5	78.0	83.3 77	73.0 76 M	98 77	93.6	3.8	94.0	52 79	58.4	5.4	58.0	JUN
JUL	15	88.0	3.5	88.0	92.9 68	80.5 83	103 75	98.5	3.4	99.0	60 83	71.1	5.5	70.0	JUL
AUG	16	86.9	4.9	85.5	95.0 71	80.9 68	103 83	97.9	3.4	98.0	54 68	70.7	9.7	69.0	AUG
SEP	12	75.8	3.7	75.0	82.1 74 M	70.2 70	97 73	90.9	3.8	91.0	43 78	58.1	7.6	56.0	SEP

MINIMUM DAILY TEMPERATURE

STATION NUMBER 101206 KRASSEL RS

1968-1983

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
MAY 1	6	37.0	2.9	37.0	40.7 80	32.9 73	48 80	45.0	3.1	45.5	24 73	28.5	3.7	28.5	MAY 1
MAY 11	7	35.5	1.5	35.0	37.9 78 M	33.2 79	48 76	42.7	4.2	42.0	23 73	28.9	2.9	30.0	MAY 11
MAY 21	7	36.6	1.5	35.0	39.0 80	34.7 73	51 79	46.7	3.2	47.0	25 73	28.3	2.9	27.0	MAY 21
JUN 1	10	38.5	3.6	37.0	46.7 77	33.6 79	58 77	46.1	4.8	45.0	25 79	30.2	3.3	29.0	JUN 1
JUN 11	10	40.5	3.5	39.0	46.4 77	36.7 71	52 77	47.2	3.2	47.5	22 81	33.6	5.7	33.0	JUN 11
JUN 21	12	42.4	4.1	42.5	49.7 73	35.1 68	56 80	51.4	3.0	52.0	29 68	34.4	4.2	34.5	JUN 21
JUL 1	14	43.1	4.4	43.5	48.9 80	35.3 69	57 81	51.1	5.1	52.5	25 71	34.7	5.5	34.5	JUL 1
JUL 11	16	43.6	3.7	43.0	53.0 75	36.7 69	61 75	51.4	4.7	50.5	30 71	37.4	4.3	38.0	JUL 11
JUL 21	16	44.9	3.6	45.0	49.4 77	37.9 68	61 77	53.6	5.4	53.5	31 69	38.3	4.3	39.5	JUL 21
AUG 1	16	43.5	4.4	43.0	54.3 83	35.0 69	62 83	51.9	5.5	52.0	28 69	37.0	4.3	37.5	AUG 1
AUG 11	16	43.4	4.3	43.0	50.3 83	35.7 70	60 83	50.6	4.9	51.5	31 70	37.6	4.3	36.5	AUG 11
AUG 21	16	40.7	3.9	40.5	47.2 83 M	34.7 70	55 76	48.9	4.8	49.5	25 69	33.7	4.4	33.0	AUG 21
SEP 1	16	37.4	3.9	38.0	46.1 78	30.4 69	54 80	45.6	4.9	46.0	21 69	29.7	4.0	30.5	SEP 1
SEP 11	15	35.3	5.4	36.0	42.7 80	22.0 71	52 80	44.7	6.2	46.0	16 71	26.5	4.8	27.0	SEP 11
SEP 21	12	33.2	5.6	32.5	43.4 76 M	26.0 71	58 78	41.5	5.8	42.0	18 71	27.1	5.7	26.5	SEP 21
OCT 1	6	29.8	2.5	30.0	32.6 75 M	25.8 74	42 81	38.8	2.5	39.5	16 74	22.7	4.2	23.5	OCT 1
MONTH															MONTH
MAY	6	36.3	1.3	35.5	38.5 80	34.6 73	51 79	48.7	1.2	48.0	23 73	26.7	2.1	27.0	MAY
JUN	7	40.3	3.5	40.0	45.8 77	36.1 68 M	58 77	52.3	4.5	53.0	22 81	28.1	3.5	28.0	JUN
JUL	15	43.8	3.4	44.0	49.8 75 M	37.1 69	61 77	56.6	3.4	57.0	25 71	33.8	4.2	34.0	JUL
AUG	16	42.5	3.8	42.5	50.6 83 M	35.9 69	62 83	54.4	3.2	53.5	25 69	33.3	3.9	33.0	AUG
SEP	12	35.2	3.9	35.0	40.0 76 M	26.8 71	58 78	47.9	3.7	48.0	16 71	24.4	4.0	25.5	SEP

(con.)

Table 21 (Con.)

MAXIMUM DAILY TEMPERATURE — MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101805 LITTLE CREEK GS — 1968-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 21	6	68.9	4.8	69.0	75.5 79	63.0 78	86 79	81.0	4.7	82.5	49 80	56.3	5.4	58.5	MAY 21
JUN 1	14	76.4	6.9	76.5	87.7 77	62.9 82 M	97 77	84.9	6.5	84.5	55 82	65.2	7.0	65.0	JUN 1
JUN 11	14	76.9	6.7	76.0	93.8 74	65.0 81	98 74	85.9	6.6	86.5	50 81	65.1	8.8	64.5	JUN 11
JUN 21	15	81.3	6.1	81.0	89.4 74	65.6 69	98 70	90.3	5.3	91.0	54 69	69.2	7.3	69.0	JUN 21
JUL 1	16	84.8	6.0	84.5	94.6 68 M	75.3 82	101 73	92.7	5.1	93.0	60 83	73.5	9.9	74.0	JUL 1
JUL 11	16	87.5	3.4	88.0	92.0 73	79.4 83	104 73	94.8	4.7	96.0	63 83	77.8	6.3	78.5	JUL 11
JUL 21	16	90.1	3.2	90.0	94.6 69	84.9 81 M	102 75	96.8	3.4	97.5	72 72	82.1	5.6	81.0	JUL 21
AUG 1	16	89.0	4.4	89.0	95.1 71	79.4 76	100 72	95.4	3.2	95.0	60 74	80.6	7.9	83.0	AUG 1
AUG 11	16	85.2	6.8	85.5	94.8 71	72.6 68	100 71	93.2	4.5	93.5	58 68	75.2	11.5	79.0	AUG 11
AUG 21	15	82.9	5.5	80.0	92.8 70	75.1 75	96 71	90.6	4.1	91.0	61 75	71.7	7.8	72.0	AUG 21
SEP 1	15	80.3	3.7	81.0	84.7 74	72.2 73	94 68	89.2	3.1	89.0	55 73	67.5	6.7	67.0	SEP 1
SEP 11	14	73.5	6.4	73.5	83.2 81 M	60.1 78	91 79	83.5	5.3	85.0	53 82	60.5	6.2	59.5	SEP 11
SEP 21	9	71.1	8.5	70.0	80.9 79	57.8 81	90 79	79.6	9.8	82.0	42 81	59.9	10.1	58.0	SEP 21
MONTH															MONTH
JUN	13	78.3	4.1	78.0	85.3 74	72.4 81 M	98 74	91.9	5.2	92.0	50 81	59.0	5.8	58.0	JUN
JUL	16	87.6	2.9	88.0	92.6 68 M	81.5 83	104 73	98.8	2.5	99.0	60 83	70.5	6.4	71.5	JUL
AUG	15	85.3	4.2	84.0	94.0 71	79.7 76	100 72	95.9	2.6	95.0	58 68	68.7	8.8	68.0	AUG
SEP	9	75.1	4.4	74.0	82.2 79	69.4 73 M	94 68	88.8	2.9	89.0	42 81	55.7	7.6	55.0	SEP

MINIMUM DAILY TEMPERATURE

STATION NUMBER 101805 LITTLE CREEK GS — 1968-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 21	6	36.3	3.1	36.5	39.6 80	32.3 82 M	50 82	45.5	3.9	45.0	23 82	27.5	3.8	27.5	MAY 21
JUN 1	14	40.1	4.2	38.0	47.0 72 M	34.6 79	54 72	45.4	4.6	44.5	26 78	32.4	4.7	31.5	JUN 1
JUN 11	14	41.1	2.7	40.5	44.8 74	35.4 78	54 69	48.2	3.2	48.5	29 80	33.9	3.5	33.0	JUN 11
JUN 21	15	43.7	3.4	44.0	50.7 73	38.9 76	58 82	50.5	3.8	50.0	27 76	36.7	4.4	38.0	JUN 21
JUL 1	16	45.1	2.7	44.0	50.9 68 M	40.4 71 M	58 75	51.6	3.3	51.5	31 71	38.1	3.6	38.5	JUL 1
JUL 11	16	47.0	3.0	46.5	52.1 73	42.3 83	62 73	54.3	4.5	53.5	35 83	40.7	3.3	40.0	JUL 11
JUL 21	16	48.2	1.9	47.5	50.7 80	44.3 81 M	61 80	55.3	3.5	56.0	34 72	42.3	4.0	42.0	JUL 21
AUG 1	16	47.6	3.0	46.0	54.0 83	43.2 76	69 80	56.7	5.0	56.0	37 76	41.4	3.8	40.0	AUG 1
AUG 11	16	46.6	3.6	46.5	51.8 72	39.0 78	62 72	53.7	4.9	54.0	33 78	40.8	3.8	41.5	AUG 11
AUG 21	15	43.8	3.0	45.0	47.8 70	38.2 78	58 73	50.6	3.7	50.0	30 77	36.7	3.9	37.0	AUG 21
SEP 1	15	40.9	2.5	40.0	44.6 78	36.3 75	55 70	48.5	3.5	49.0	25 76	32.7	3.8	34.0	SEP 1
SEP 11	14	37.5	3.7	36.5	42.7 68 M	31.9 78	52 68	46.1	4.7	47.0	18 83	28.8	5.8	29.0	SEP 11
SEP 21	9	34.6	2.3	34.0	38.3 79	30.9 75	45 82	40.3	3.5	41.0	24 78	28.2	3.7	27.0	SEP 21
MONTH															MONTH
JUN	13	42.0	2.1	42.0	45.0 77	37.6 78	58 82	51.8	3.7	52.0	26 78	30.5	3.3	30.0	JUN
JUL	16	46.8	1.4	46.0	50.3 75	44.8 83	62 73	57.8	2.7	57.5	31 71	37.2	2.9	38.0	JUL
AUG	15	45.9	2.8	45.0	49.9 71	40.8 78	69 80	57.5	4.7	57.0	30 77	36.3	3.6	36.0	AUG
SEP	9	37.8	1.9	37.0	40.3 80	35.1 75	55 70	49.3	2.3	50.0	18 83	25.8	4.7	27.0	SEP

Table 22—Frequencies of daily maximum and minimum temperature values

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 100835 BIG CREEK 1 S 1949-1967

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1			6	19	38	88	250	225	231	113	31												JAN 1
JAN 11			12	43	37	123	184	221	239	92	43	6											JAN 11
JAN 21			5	37	48	123	91	203	283	128	70	11											JAN 21
FEB 1				17	22	45	73	180	236	258	107	51	11										FEB 1
FEB 11					18	59	88	224	276	206	76	47	6										FEB 11
FEB 21				7	21	28	97	138	248	248	110	76	28										FEB 21
MAR 1						24	88	212	282	153	188	29	24										MAR 1
MAR 11						6	47	129	247	276	171	71	35	12	6								MAR 11
MAR 21						5	11	102	176	219	193	150	96	43	5								MAR 21
APR 1								23	98	220	272	173	116	69	29								APR 1
APR 11								28	106	144	222	172	144	106	61	17							APR 11
APR 21								6	78	167	172	172	189	139	44	33							APR 21
MAY 1								6	17	106	150	144	189	200	72	72	39	6					MAY 1
MAY 11										51	91	114	148	199	153	131	80	34					MAY 11
MAY 21										25	66	86	182	131	177	182	91	56	5				MAY 21
JUN 1											56	73	102	203	124	237	130	68	6				JUN 1
JUN 11											6	67	144	94	156	250	172	61	50				JUN 11
JUN 21											6	17	94	133	150	167	228	139	61	6			JUN 21
JUL 1													22	50	83	150	211	289	178	11	6		JUL 1
JUL 11														6	39	111	200	256	250	111	28		JUL 11
JUL 21													5		25	81	107	355	315	96	15		JUL 21
AUG 1														11	26	68	205	279	311	84	16		AUG 1
AUG 11														11	42	53	184	332	295	84			AUG 11
AUG 21										5	10	10	34	91	154	130	178	236	135	19			AUG 21
SEP 1											6	12	30	48	161	190	208	244	77	24			SEP 1
SEP 11											36	78	78	102	151	181	175	145	54				SEP 11
SEP 21										35	41	71	65	165	147	165	135	165	12				SEP 21
OCT 1									19	44	69	113	106	113	150	200	181	6					OCT 1
OCT 11									25	50	125	138	156	181	194	94	38						OCT 11
OCT 21								34	91	142	131	176	125	182	114	6							OCT 21
NOV 1							18	36	136	213	237	178	112	65	6								NOV 1
NOV 11			12		12	24	41	141	265	235	124	100	47										NOV 11
NOV 21						24	95	207	290	195	124	36	6	18	6								NOV 21
DEC 1					17	56	144	300	317	111	44	11											DEC 1
DEC 11	6	6		24	30	60	108	283	331	139	12												DEC 11
DEC 21				6	23	102	210	233	301	114	11												DEC 21
MONTH																							MONTH
JAN			8	33	41	112	171	216	253	112	49	6											JAN
FEB				8	20	45	85	183	254	237	97	57	14										FEB
MAR						11	47	146	233	216	184	85	53	19	4								MAR
APR								19	94	176	221	173	150	105	45	17							APR
MAY								2	5	60	101	114	173	175	135	130	70	32	2				MAY
JUN											22	52	114	143	143	218	177	89	39	2			JUN
JUL													9	18	48	113	171	302	250	74	16		JUL
AUG										2	3	3	12	39	77	85	189	281	243	61	5		AUG
SEP										12	28	54	58	105	153	179	173	185	48	8			SEP
OCT								12	46	81	109	143	129	159	151	97	71	2					OCT
NOV			4		4	16	51	128	230	215	161	104	55	28	4								NOV
DEC	2	2		10	23	73	155	272	316	121	23	4											DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 100835 BIG CREEK 1 S 1949-1967

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	313	88	125	150	106	119	75	25															JAN 1
JAN 11	288	74	98	74	147	129	135	49	6														JAN 11
JAN 21	283	107	91	144	102	91	118	64															JAN 21
FEB 1	258	112	112	90	107	140	118	62															FEB 1
FEB 11	194	76	124	59	176	188	124	59															FEB 11
FEB 21	234	97	83	117	193	110	110	55															FEB 21
MAR 1	194	135	106	153	153	129	88	35	6														MAR 1
MAR 11	194	100	112	129	100	200	129	35															MAR 11
MAR 21	53	59	80	176	171	198	171	91															MAR 21
APR 1	12	23	64	133	243	243	173	110															APR 1
APR 11		11	33	133	150	317	228	128															APR 11
APR 21		6	6	44	144	250	394	133	22														APR 21
MAY 1			6	11	94	217	367	217	72	17													MAY 1
MAY 11					23	165	438	239	125	11													MAY 11
MAY 21				5	10	101	359	268	187	71													MAY 21
JUN 1					6	17	260	311	260	130	17												JUN 1
JUN 11						22	222	294	306	117	39												JUN 11
JUN 21						22	172	350	267	128	44	17											JUN 21
JUL 1						11	167	300	322	161	33	6											JUL 1
JUL 11						6	94	244	422	144	61	22	6										JUL 11
JUL 21						10	122	289	320	157	71	15	15										JUL 21
AUG 1							121	368	258	126	95	32											AUG 1
AUG 11						16	179	400	221	95	68	21											AUG 11
AUG 21					5	19	288	293	231	125	29	10											AUG 21
SEP 1					18	106	400	206	182	47	35	6											SEP 1
SEP 11				6	41	165	400	176	129	59	24												SEP 11
SEP 21					82	265	353	159	129	12													SEP 21
OCT 1				25	119	325	306	119	75	31													OCT 1
OCT 11				69	150	313	163	225	69	13													OCT 11
OCT 21			17	165	210	261	216	108	11	11													OCT 21
NOV 1	36	59	77	178	260	183	136	59	12														NOV 1
NOV 11	135	41	71	65	135	182	206	129	29	6													NOV 11
NOV 21	206	76	71	106	141	141	188	59	6	6													NOV 21
DEC 1	211	117	67	133	139	228	78	28															DEC 1
DEC 11	228	120	42	120	120	210	102	60															DEC 11
DEC 21	301	85	148	114	153	119	40	34	6														DEC 21
MONTH																							MONTH
JAN	294	90	104	124	118	112	110	47	2														JAN
FEB	229	95	108	87	156	148	118	59															FEB
MAR	144	97	99	154	142	176	131	55	2														MAR
APR	4	13	34	103	178	270	266	124	8														APR
MAY			2	5	42	159	386	242	130	34													MAY
JUN					2	20	218	318	277	125	34	6											JUN
JUL						9	127	278	354	154	56	14	7										JUL
AUG					2	12	199	352	236	116	63	20											AUG
SEP				2	47	178	384	180	147	39	20	2											SEP
OCT			6	89	161	298	228	149	50	18													OCT
NOV	126	59	73	116	179	169	177	83	16	4													NOV
DEC	247	107	86	122	138	185	73	40	2														DEC

(con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101663 CHALLIS 1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	3	37	41	64	108	142	152	162	149	105	24	14											JAN 1
JAN 11	3	3	3	30	74	97	134	188	198	158	97	10	3										JAN 11
JAN 21	9	21	15	36	49	73	164	201	204	155	40	21	12										JAN 21
FEB 1	7		7	23	17	23	107	213	233	203	107	47	13										FEB 1
FEB 11				3	10	33	100	194	201	191	164	84	20										FEB 11
FEB 21				20	12	37	41	131	241	196	200	90	24	8									FEB 21
MAR 1				7		7	87	104	228	218	191	101	37	17	3								MAR 1
MAR 11							27	70	150	233	250	157	73	27	13								MAR 11
MAR 21						3		12	76	158	198	195	170	112	55	21							MAR 21
APR 1									31	92	156	241	173	167	85	48	7						APR 1
APR 11									13	63	127	183	193	207	113	73	20	7					APR 11
APR 21									7	37	117	167	177	163	157	130	30	13	3				APR 21
MAY 1										17	47	88	135	178	178	222	84	27	24				MAY 1
MAY 11											40	84	131	138	152	182	158	94	17	3			MAY 11
MAY 21											9	44	97	153	188	159	200	100	41	9			MAY 21
JUN 1												17	84	120	124	154	214	204	60	23			JUN 1
JUN 11												3	37	67	134	191	211	224	77	43	13		JUN 11
JUN 21												7	30	47	104	134	141	181	198	138	20		JUN 21
JUL 1														27	13	104	117	171	314	224	30		JUL 1
JUL 11															13	20	64	194	328	288	87	7	JUL 11
JUL 21														6	6	18	36	130	333	373	85	12	JUL 21
AUG 1														7	21	35	80	163	356	273	55	10	AUG 1
AUG 11													7	34	38	48	76	203	317	238	38		AUG 11
AUG 21													6	44	63	135	172	197	245	113	25		AUG 21
SEP 1													7	50	84	130	204	251	227	47			SEP 1
SEP 11										7	10	23	47	120	143	157	170	243	73	7			SEP 11
SEP 21										7	17	43	47	130	140	210	210	160	30	7			SEP 21
OCT 1										3	20	107	77	114	137	237	244	60					OCT 1
OCT 11										18	67	134	137	190	211	180	56	7					OCT 11
OCT 21							6		22	75	178	178	199	174	134	34							OCT 21
NOV 1						3	7	37	41	160	265	228	160	75	24								NOV 1
NOV 11			3	3		21	27	148	137	223	213	124	58	38	3								NOV 11
NOV 21				7	17	41	48	187	204	231	156	92	17										NOV 21
DEC 1		7	14	7	17	27	140	253	226	185	82	38	3										DEC 1
DEC 11			17	31	17	115	157	227	199	175	52	7											DEC 11
DEC 21	3	3	6	32	38	155	180	244	171	104	51	9	3										DEC 21
MONTH																							MONTH
JAN	5	21	20	43	76	103	151	184	184	140	53	15	5										JAN
FEB	2		2	15	13	31	85	182	224	197	154	72	19	2									FEB
MAR				2		3	37	60	149	202	213	152	96	54	25	8							MAR
APR									17	64	133	197	181	179	119	84	19	7	1				APR
MAY										5	32	71	120	156	173	187	149	74	27	4			MAY
JUN												9	50	78	121	160	189	203	112	68	11		JUN
JUL														11	11	46	71	164	325	297	68	6	JUL
AUG													4	29	41	75	111	188	304	205	39	3	AUG
SEP										4	9	22	33	100	122	166	195	218	110	20			SEP
OCT							2		8	33	91	140	139	159	159	147	98	22					OCT
NOV			1	3	6	22	27	124	127	205	212	148	78	38	9								NOV
DEC	1	3	12	23	25	101	160	242	198	153	62	18	2										DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101663 CHALLIS

1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	292	94	138	161	121	91	77	17	10														JAN 1
JAN 11	140	103	137	130	147	147	73	107	17														JAN 11
JAN 21	161	115	176	164	158	79	70	67	9	3													JAN 21
FEB 1	88	57	141	232	178	152	98	44	10														FEB 1
FEB 11	31	61	99	174	164	218	140	92	20														FEB 11
FEB 21	53	53	98	147	176	212	163	65	33														FEB 21
MAR 1	34	47	67	148	188	252	134	107	20	3													MAR 1
MAR 11	7	20	43	137	177	277	193	127	20														MAR 11
MAR 21		6	18	36	134	216	310	216	58	3	3												MAR 21
APR 1				14	54	207	313	235	136	41													APR 1
APR 11					33	150	267	327	170	43	10												APR 11
APR 21					3	70	203	317	267	117	23												APR 21
MAY 1					7	13	111	249	286	256	71	7											MAY 1
MAY 11						7	84	196	284	287	115	24	3										MAY 11
MAY 21							22	118	259	299	227	72	3										MAY 21
JUN 1							10	84	141	285	282	164	34										JUN 1
JUN 11								43	80	261	388	181	47										JUN 11
JUN 21							3	40	87	185	326	248	104	7									JUN 21
JUL 1								7	23	163	343	330	110	13	10								JUL 1
JUL 11									3	57	237	435	234	33									JUL 11
JUL 21									6	36	215	479	203	61									JUL 21
AUG 1									14	111	287	381	173	31	3								AUG 1
AUG 11								3	21	114	369	366	100	24	3								AUG 11
AUG 21								22	107	229	376	207	44	13	3								AUG 21
SEP 1								47	174	294	301	137	43	3									SEP 1
SEP 11					3	10	30	123	190	357	230	43	10	3									SEP 11
SEP 21						10	70	200	360	227	127	7											SEP 21
OCT 1						50	124	281	351	147	30	10	7										OCT 1
OCT 11				4	25	67	200	354	207	105	32	7											OCT 11
OCT 21		3		12	93	190	280	255	115	37	9	3											OCT 21
NOV 1		3	20	58	150	265	228	136	109	20	7	3											NOV 1
NOV 11	14	27	69	93	192	165	223	144	69	3													NOV 11
NOV 21	48	44	99	163	184	194	146	95	17	7	3												NOV 21
DEC 1	64	51	121	239	178	158	135	40	13														DEC 1
DEC 11	105	66	146	202	185	174	87	35															DEC 11
DEC 21	104	119	220	160	138	123	79	44	13														DEC 21
MONTH																							MONTH
JAN	196	105	151	152	142	105	73	64	12	1													JAN
FEB	57	57	114	187	172	193	132	67	20														FEB
MAR	13	24	42	105	165	247	216	152	33	2	1												MAR
APR				4	30	142	261	293	191	67	11												APR
MAY					2	7	71	186	276	281	140	35	2										MAY
JUN							4	56	103	244	332	198	61	2									JUN
JUL								2	11	84	264	417	183	37	3								JUL
AUG								9	49	154	345	314	104	22	3								AUG
SEP					1	7	33	123	241	293	219	62	18	2									SEP
OCT		1		6	41	105	203	295	222	95	23	7	2										OCT
NOV	20	25	63	105	175	208	199	125	65	10	3	1											NOV
DEC	91	80	164	200	166	151	100	40	9														DEC

(con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101932 COBALT 1962-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	10	30	61	86	76	162	111	192	202	51	20												JAN 1
JAN 11		15	5	15	50	120	140	230	175	210	30	5	5										JAN 11
JAN 21		9	27	46	78	105	128	219	228	128	23	5	5										JAN 21
FEB 1				15	40	40	90	180	300	245	80	10											FEB 1
FEB 11					5	25	55	165	220	250	220	55	5										FEB 11
FEB 21				6	12	12	42	48	206	333	206	121	12										FEB 21
MAR 1							32	111	169	270	228	132	42	11	5								MAR 1
MAR 11						5	5	37	159	233	259	175	85	42									MAR 11
MAR 21						5	10	48	101	212	216	159	149	63	38								MAR 21
APR 1								6	67	161	194	228	172	94	61	11	6						APR 1
APR 11									28	83	178	250	128	133	111	50	39						APR 11
APR 21									28	89	112	179	156	128	101	123	73	11					APR 21
MAY 1										30	54	113	161	173	202	179	89						MAY 1
MAY 11										12	101	89	71	202	125	179	137	83					MAY 11
MAY 21										5	27	65	87	223	109	212	158	92	22				MAY 21
JUN 1												12	107	131	131	208	155	196	48	12			JUN 1
JUN 11												24	72	96	144	192	240	114	66	48	6		JUN 11
JUN 21											6	24	24	84	48	175	133	253	181	72			JUN 21
JUL 1													6	18	47	82	176	247	276	129	12	6	JUL 1
JUL 11													6	12		53	135	288	306	188	12		JUL 11
JUL 21														21	16	37	75	171	417	241	21		JUL 21
AUG 1														11	28	56	106	228	361	194	17		AUG 1
AUG 11												11	16	37	26	89	116	195	316	189	5		AUG 11
AUG 21													19	29	63	159	168	293	159	101	10		AUG 21
SEP 1												16	21	26	84	137	189	268	216	42			SEP 1
SEP 11											34	67	73	124	101	180	174	174	56	17			SEP 11
SEP 21									5		32	53	89	116	142	205	168	137	53				SEP 21
OCT 1										26	74	90	69	153	175	175	196	42					OCT 1
OCT 11									16	63	79	179	142	189	211	74	47						OCT 11
OCT 21						5		14	28	109	199	199	194	156	85	9							OCT 21
NOV 1							11	21	101	259	233	201	132	37	5								NOV 1
NOV 11					16	5	47	126	200	242	163	153	32	16									NOV 11
NOV 21				11	16	63	105	221	358	163	53	11											NOV 21
DEC 1		32	16	5	11	74	154	266	213	138	69	16	5										DEC 1
DEC 11		5	22	48	43	145	188	199	253	70	27												DEC 11
DEC 21	10	5	15	25	65	214	154	224	169	95	20	5											DEC 21
MONTH																							MONTH
JAN	3	18	31	49	68	128	126	214	203	130	24	3	3										JAN
FEB				7	19	27	64	136	244	273	166	58	5										FEB
MAR						3	15	65	142	237	234	155	94	39	15								MAR
APR								2	41	111	161	219	152	119	91	61	39	4					APR
MAY										15	60	88	106	200	144	190	129	60	8				MAY
JUN											2	20	68	104	108	192	176	188	98	44	2		JUN
JUL													4	17	21	57	127	233	336	188	15	2	JUL
AUG												3	12	26	40	104	131	240	273	159	10		AUG
SEP									2		22	45	61	88	109	174	177	194	109	20			SEP
OCT						2		5	15	68	120	158	137	166	154	83	78	14					OCT
NOV				4	11	23	54	123	220	221	149	121	54	18	2								NOV
DEC	3	14	17	26	40	146	165	230	210	101	38	7	2										DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101932 COBALT 1962-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	359	111	172	96	136	86	30	10															JAN 1
JAN 11	225	95	140	140	150	90	90	70															JAN 11
JAN 21	317	133	133	133	83	83	87	32															JAN 21
FEB 1	115	205	150	190	145	120	60	15															FEB 1
FEB 11	105	100	100	175	210	155	80	75															FEB 11
FEB 21	103	103	133	158	218	158	85	42															FEB 21
MAR 1	95	69	127	175	201	159	116	53	5														MAR 1
MAR 11	53	85	127	148	201	201	148	32	5														MAR 11
MAR 21	5	24	67	115	250	221	231	77	5	5													MAR 21
APR 1		11	22	67	161	317	278	139	6														APR 1
APR 11			6	44	150	311	328	139	17	6													APR 11
APR 21				6	61	218	358	246	101	11													APR 21
MAY 1				6	18	83	292	393	149	48	12												MAY 1
MAY 11					6	36	304	369	208	77													MAY 11
MAY 21						27	174	359	304	114	16			5									MAY 21
JUN 1							77	256	333	220	95	18											JUN 1
JUN 11							42	174	287	353	132	12											JUN 11
JUN 21							24	133	277	373	151	36	6										JUN 21
JUL 1							12	153	171	394	224	47											JUL 1
JUL 11								53	206	435	188	82	35										JUL 11
JUL 21								21	176	476	230	80	11	5									JUL 21
AUG 1							6	61	267	394	183	72	17										AUG 1
AUG 11								58	253	474	174	37	5										AUG 11
AUG 21							34	178	361	269	130	24	5										AUG 21
SEP 1						21	79	263	379	174	53	32											SEP 1
SEP 11					6	56	140	315	315	112	51	6											SEP 11
SEP 21					16	74	232	363	232	68	16												SEP 21
OCT 1				5	37	164	339	323	95	37													OCT 1
OCT 11			5	16	79	274	353	158	89	26													OCT 11
OCT 21	5		9	43	185	303	270	152	24	9													OCT 21
NOV 1	5	11	16	106	190	291	201	148	26	5													NOV 1
NOV 11	21	26	74	121	158	300	158	121	11	11													NOV 11
NOV 21	53	105	163	200	189	147	105	37															NOV 21
DEC 1	86	119	157	146	211	141	114	27															DEC 1
DEC 11	181	124	175	158	147	124	51	40															DEC 11
DEC 21	200	179	164	205	92	103	41	15															DEC 21
MONTH																							MONTH
JAN	300	114	148	123	122	86	70	37															JAN
FEB	108	138	127	175	189	143	74	44															FEB
MAR	49	58	106	145	218	195	167	55	5	2													MAR
APR		4	9	39	124	282	321	174	41	6													APR
MAY				2	8	48	254	373	223	81	10			2									MAY
JUN							48	188	299	315	126	22	2										JUN
JUL							4	74	184	436	214	70	15	2									JUL
AUG							14	102	296	375	161	43	9										AUG
SEP					7	50	151	314	308	118	39	13											SEP
OCT	2		5	22	103	249	319	208	68	24													OCT
NOV	26	47	84	142	179	246	155	102	12	5													NOV
DEC	156	142	165	171	149	122	68	27															DEC

(con.)

Table 22 (Con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 102575 DIXIE 1952-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1		7	7	64	114	168	168	232	154	75	11												JAN 1
JAN 11			7	14	36	93	232	264	243	86	25												JAN 11
JAN 21		3	6	23	81	136	140	289	156	140	26												JAN 21
FEB 1				7	29	50	132	264	257	139	71	43	7										FEB 1
FEB 11					14	25	175	225	329	139	57	36											FEB 11
FEB 21				13	13	48	121	199	277	160	117	35	17										FEB 21
MAR 1					18	50	157	204	246	200	79	25	21										MAR 1
MAR 11					7	14	75	214	271	204	121	68	18	7									MAR 11
MAR 21					3	13	55	130	221	237	127	107	75	32									MAR 21
APR 1							14	104	193	250	211	104	79	32	14								APR 1
APR 11							4	50	193	236	204	154	89	46	18	7							APR 11
APR 21								29	139	218	218	150	125	54	54	7	7						APR 21
MAY 1								21	71	121	154	168	182	150	71	43	14	4					MAY 1
MAY 11									29	114	125	125	171	161	125	93	39	18					MAY 11
MAY 21									23	68	123	133	169	114	162	123	65	19					MAY 21
JUN 1										11	68	100	146	175	164	175	118	36	7				JUN 1
JUN 11										18	32	107	136	129	193	168	129	57	32				JUN 11
JUN 21										14	29	57	104	114	179	175	154	150	25				JUN 21
JUL 1												14	62	90	110	183	279	176	86				JUL 1
JUL 11												7	14	38	114	179	217	262	145	21	3		JUL 11
JUL 21													5	22	38	82	292	376	154	28			JUL 21
AUG 1													11	18	75	139	236	350	146	14	11		AUG 1
AUG 11											18	21	43	29	61	86	304	246	175	18			AUG 11
AUG 21										3	16	32	42	110	159	156	218	153	84	26			AUG 21
SEP 1										3	28	41	55	141	121	197	207	152	45	10			SEP 1
SEP 11									10	21	45	117	124	110	159	183	124	97	10				SEP 11
SEP 21									14	72	66	86	124	121	141	172	138	66					SEP 21
OCT 1									34	103	97	76	110	100	186	197	97						OCT 1
OCT 11								3	59	110	152	114	134	193	121	107	7						OCT 11
OCT 21						3	9	57	142	160	135	138	182	119	53								OCT 21
NOV 1						4	32	64	207	214	179	146	129	25									NOV 1
NOV 11		4		4	18	29	86	154	286	189	150	68	11	4									NOV 11
NOV 21				7	7	46	139	268	250	161	82	25	14										NOV 21
DEC 1			17	17	17	59	193	245	255	131	59	7											DEC 1
DEC 11		3	10	7	28	131	148	214	307	131	21												DEC 11
DEC 21		9	6		16	135	229	260	245	85	16												DEC 21
MONTH																							MONTH
JAN		3	7	33	77	132	179	263	183	101	21												JAN
FEB				6	19	40	144	231	288	145	80	38	8										FEB
MAR					9	25	94	181	245	214	109	68	39	14									MAR
APR							6	61	175	235	211	136	98	44	29	5	2						APR
MAY								7	40	100	134	142	174	141	121	88	40	14					MAY
JUN										14	43	88	129	139	179	173	133	81	21				JUN
JUL												7	28	49	86	146	264	275	129	17	1		JUL
AUG										1	12	18	32	54	100	128	251	247	134	20	3		AUG
SEP									8	32	46	82	101	124	140	184	156	105	18	3			SEP
OCT						1	3	21	80	126	128	110	144	137	118	98	33						OCT
NOV		1		4	8	26	86	162	248	188	137	80	51	10									NOV
DEC		4	11	8	20	109	191	240	268	115	31	2											DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 102575 DIXIE

1952-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	443	86	89	143	89	79	43	25	4														JAN 1
JAN 11	286	89	93	111	125	118	107	71															JAN 11
JAN 21	377	117	117	97	91	101	81	19															JAN 21
FEB 1	336	89	111	139	129	114	54	25	4														FEB 1
FEB 11	207	100	132	161	161	121	68	50															FEB 11
FEB 21	251	139	113	177	117	108	61	35															FEB 21
MAR 1	257	111	100	161	171	121	50	29															MAR 1
MAR 11	211	111	161	154	118	168	64	14															MAR 11
MAR 21	101	71	107	188	195	166	114	58															MAR 21
APR 1	21	46	64	171	193	264	161	79															APR 1
APR 11	14	29	71	154	186	211	239	96															APR 11
APR 21			18	86	125	296	346	125	4														APR 21
MAY 1		4	14	32	75	239	364	236	29	7													MAY 1
MAY 11			4	7	29	221	382	289	61	7													MAY 11
MAY 21				3	16	130	308	351	149	36	6												MAY 21
JUN 1						50	254	332	200	132	29	4											JUN 1
JUN 11						11	164	332	293	175	25												JUN 11
JUN 21						21	150	321	296	146	57	7											JUN 21
JUL 1						10	134	269	366	145	66	10											JUL 1
JUL 11							66	276	310	221	93	31	3										JUL 11
JUL 21						3	91	260	389	150	75	31											JUL 21
AUG 1							118	382	286	129	71	14											AUG 1
AUG 11						7	132	393	254	157	57												AUG 11
AUG 21					3	32	273	341	240	68	42												AUG 21
SEP 1					21	97	376	259	179	38	28	3											SEP 1
SEP 11			3	17	38	183	331	210	152	41	24												SEP 11
SEP 21				3	93	203	393	245	52	10													SEP 21
OCT 1				41	145	359	297	107	48	3													OCT 1
OCT 11			14	93	166	324	228	148	24	3													OCT 11
OCT 21	13	6	50	101	261	280	208	72	6	3													OCT 21
NOV 1	39	36	107	171	221	193	154	79															NOV 1
NOV 11	136	50	71	114	196	182	164	75	11														NOV 11
NOV 21	221	121	118	121	154	143	96	21	4														NOV 21
DEC 1	259	103	121	162	145	103	83	24															DEC 1
DEC 11	310	103	128	124	117	93	93	31															DEC 11
DEC 21	326	135	113	100	138	103	47	34	3														DEC 21
MONTH																							MONTH
JAN	369	98	100	116	101	99	77	38	I														JAN
FEB	265	107	119	158	137	115	61	37	1														FEB
MAR	187	97	122	168	162	152	77	35															MAR
APR	12	25	51	137	168	257	249	100	I														APR
MAY		1	6	14	39	195	350	294	82	17	2												MAY
JUN						27	189	329	263	151	37	4											JUN
JUL						4	97	268	356	171	78	24	1										JUL
AUG					I	14	177	371	259	116	56	5											AUG
SEP			I	7	51	161	367	238	128	30	17	1											SEP
OCT	4	2	22	79	193	320	243	108	26	3													OCT
NOV	132	69	99	136	190	173	138	58	5														NOV
DEC	299	115	120	128	133	100	73	30	1														DEC

(con.)

Table 22 (Con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 105708 MC CALL 1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1		3		40	90	187	217	270	140	50	3												JAN 1
JAN 11			10	3	33	133	190	273	280	63	13												JAN 11
JAN 21		3	3	27	36	158	158	348	170	88	9												JAN 21
FEB 1				7	23	37	73	340	317	147	33	13	10										FEB 1
FEB 11		3			7	63	87	337	230	177	73	23											FEB 11
FEB 21				8	8	73	81	218	290	169	117	36											FEB 21
MAR 1					3	53	103	213	250	220	113	33	3	7									MAR 1
MAR 11						7	53	217	253	247	147	47	17	13									MAR 11
MAR 21						3	18	106	236	297	130	97	79	33									MAR 21
APR 1								33	163	243	200	177	120	43	17	3							APR 1
APR 11								33	107	193	223	197	130	73	40	3							APR 11
APR 21								23	87	173	153	190	133	130	50	40	17	3					APR 21
MAY 1								10	30	113	80	147	207	183	137	63	17	13					MAY 1
MAY 11								7	3	53	97	153	117	203	153	127	63	23					MAY 11
MAY 21									6	33	58	112	155	179	152	188	79	33	6				MAY 21
JUN 1										7	13	87	100	170	153	227	167	60	13	3			JUN 1
JUN 11										3	7	73	97	133	150	203	190	83	40	20			JUN 11
JUN 21												37	63	133	143	180	147	177	120				JUN 21
JUL 1											3		17	53	70	187	217	253	167	30	3		JUL 1
JUL 11													3	7	23	110	197	310	277	70	3		JUL 11
JUL 21															9	52	118	318	406	97			JUL 21
AUG 1														10	33	93	173	293	313	77	7		AUG 1
AUG 11											3	7	23	20	53	57	183	300	283	67	3		AUG 11
AUG 21											6	9	52	82	109	185	185	191	136	39	6		AUG 21
SEP 1											7	7	30	110	123	190	227	230	70	7			SEP 1
SEP 11										7	20	63	107	170	117	183	173	143	17				SEP 11
SEP 21									3	7	67	77	103	153	170	167	150	97	7				SEP 21
OCT 1									10	47	60	140	100	120	207	193	113	10					OCT 1
OCT 11									13	90	110	150	117	253	137	103	27						OCT 11
OCT 21							6	49	76	146	140	179	173	140	88	3							OCT 21
NOV 1							10	53	107	247	187	203	130	57	7								NOV 1
NOV 11		3		10	7	13	37	217	240	213	150	93	17										NOV 11
NOV 21						27	97	297	283	200	60	27	7	3									NOV 21
DEC 1			7	20	20	63	133	323	263	100	63	7											DEC 1
DEC 11			7	17	10	117	200	290	257	80	23												DEC 11
DEC 21			6	15	24	115	255	361	155	61	9												DEC 21
MONTH																							MONTH
JAN		2	4	24	53	159	187	299	196	68	9												JAN
FEB		I		5	13	57	80	303	278	164	72	24	4										FEB
MAR					1	20	57	176	246	256	130	60	34	18									MAR
APR								30	119	203	192	188	128	82	36	16	6	1					APR
MAY								5	13	66	77	137	159	188	147	128	54	24	2				MAY
JUN										3	7	66	87	146	149	203	168	107	58	8			JUN
JUL											1		6	19	33	114	175	295	287	67	2		JUL
AUG											3	5	26	39	67	114	181	259	241	60	5		AUG
SEP									1	4	31	49	80	144	137	180	183	157	31	2			SEP
OCT							2	17	34	96	104	157	131	170	142	97	45	3					OCT
NOV		1		3	2	13	48	189	210	220	132	108	51	20	2								NOV
DEC			6	17	18	99	198	326	223	80	31	2											DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 105708 MC CALL 1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	260	77	93	167	110	137	83	70	3														JAN 1
JAN 11	117	77	77	133	127	170	133	153	13														JAN 11
JAN 21	218	106	91	136	109	155	103	82															JAN 21
FEB 1	143	93	157	93	137	137	140	100															FEB 1
FEB 11	90	97	103	123	160	163	157	107															FEB 11
FEB 21	137	97	85	161	161	157	109	89	4														FEB 21
MAR 1	110	80	97	213	147	143	97	110	3														MAR 1
MAR 11	83	77	120	150	163	173	167	57	10														MAR 11
MAR 21	24	45	42	133	145	267	197	145															MAR 21
APR 1	7	3	20	50	160	277	303	173	7														APR 1
APR 11				40	107	313	290	230	20														APR 11
APR 21				3	43	153	393	310	90	7													APR 21
MAY 1					10	80	240	390	210	67	3												MAY 1
MAY 11					7	37	167	397	257	123	13												MAY 11
MAY 21					3	18	103	309	285	200	61	18	3										MAY 21
JUN 1							53	187	273	297	147	37	7										JUN 1
JUN 11							17	123	260	320	217	57	7										JUN 11
JUN 21						3	23	123	257	323	213	43	13										JUN 21
JUL 1							10	63	180	363	247	117	20										JUL 1
JUL 11								10	177	263	300	197	40	13									JUL 11
JUL 21								21	112	367	270	158	70	3									JUL 21
AUG 1							7	43	163	350	257	120	57	3									AUG 1
AUG 11							3	63	227	347	243	70	43		3								AUG 11
AUG 21							48	161	258	306	161	55	12										AUG 21
SEP 1						7	77	220	320	227	120	23	3	3									SEP 1
SEP 11					3	37	110	263	277	200	93	17											SEP 11
SEP 21					3	77	180	330	240	120	43	7											SEP 21
OCT 1				3	30	120	230	393	120	70	33												OCT 1
OCT 11				3	27	177	273	310	130	73	3	3											OCT 11
OCT 21			6	30	76	240	328	234	61	18	6												OCT 21
NOV 1		3	13	47	123	257	257	237	53	10													NOV 1
NOV 11	17	23	57	113	123	160	193	233	80														NOV 11
NOV 21	40	33	90	140	173	157	197	163	7														NOV 21
DEC 1	53	43	87	200	130	220	163	100	3														DEC 1
DEC 11	67	84	114	144	174	134	140	134	10														DEC 11
DEC 21	82	106	158	152	118	161	121	94	9														DEC 21
MONTH																							MONTH
JAN	199	87	87	145	115	154	106	101	5														JAN
FEB	123	96	117	124	152	152	137	99	1														FEB
MAR	71	67	85	165	152	197	155	105	4														MAR
APR	2	1	7	31	103	248	329	238	39	2													APR
MAY					6	44	168	363	252	132	27	6	1										MAY
JUN						1	31	144	263	313	192	46	9										JUN
JUL							3	31	155	332	272	157	44	5									JUL
AUG							20	91	217	333	218	81	37	1	1								AUG
SEP					2	40	122	271	279	182	86	16	1	1									SEP
OCT			2	13	45	181	279	310	102	53	14	1											OCT
NOV	19	20	53	100	140	191	216	211	47	3													NOV
DEC	68	79	121	165	140	171	141	109	8														DEC

(con.)

Table 22 (Con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 105897 MIDDLE FORK LODGE 1971-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1		20	51	131	61	101	152	152	263	61			10										JAN 1
JAN 11					10	50	150	120	290	280	80	20											JAN 11
JAN 21				18	55	46	147	211	266	202	55												JAN 21
FEB 1				11	44	67	44	89	289	344	100	11											FEB 1
FEB 11							11	44	267	333	178	89	78										FEB 11
FEB 21							14	41	162	338	257	162	14	14									FEB 21
MAR 1							20	70	100	160	280	240	100	20		10							MAR 1
MAR 11									100	210	210	190	120	130	40								MAR 11
MAR 21							9	19	111	194	241	139	120	56	93	19							MAR 21
APR 1									48	124	267	200	133	105	67	38	19						APR 1
APR 11									18	64	164	164	182	191	100	73	45						APR 11
APR 21										28	83	119	220	193	110	110	110	28					APR 21
MAY 1										30	60	80	160	230	250	100	80	10					MAY 1
MAY 11											70	100	170	120	90	200	150	80	20				MAY 11
MAY 21											9	64	91	155	218	218	100	127	18				MAY 21
JUN 1												9	19	140	121	178	215	234	56	19	9		JUN 1
JUN 11											9	37	55	83	128	183	229	119	83	28	46		JUN 11
JUN 21												9	9	27	127	100	164	236	182	118	27		JUN 21
JUL 1														23	23	114	170	227	216	136	91		JUL 1
JUL 11															33	11	111	211	267	267	89	11	JUL 11
JUL 21														11		21	63	137	242	379	126	21	JUL 21
AUG 1															40	40	71	131	263	293	152	10	AUG 1
AUG 11														51	30	61	91	202	222	242	101		AUG 11
AUG 21													9	37	64	92	174	239	193	119	73		AUG 21
SEP 1													10	20	40	100	160	350	220	100			SEP 1
SEP 11										10		20	111	61	121	121	192	162	111	61	30		SEP 11
SEP 21										10	20	51	92	122	92	204	194	143	61	10			SEP 21
OCT 1										10	19	67	95	95	181	114	305	95	19				OCT 1
OCT 11										20	59	108	186	98	235	167	108	20					OCT 11
OCT 21							8		41	107	149	207	215	157	91	25							OCT 21
NOV 1							11	21	64	128	223	181	255	106	11								NOV 1
NOV 11							11	43	247	269	312	54	43	22									NOV 11
NOV 21						30	80	210	290	210	110	60	10										NOV 21
DEC 1		10	20	40	20	20	50	170	300	150	150	50	20										DEC 1
DEC 11		11		22	43	22	97	226	269	247	54	11											DEC 11
DEC 21		9	9		19	65	176	194	259	185	74	9											DEC 21
MONTH																							MONTH
JAN		6	16	49	42	65	149	162	273	182	45	6	3										JAN
FEB				4	16	24	24	59	244	339	173	83	31	4									FEB
MAR							10	29	104	188	244	188	114	68	45	10							MAR
APR									22	71	170	160	179	164	93	74	59	9					APR
MAY										10	45	81	139	168	187	174	110	74	13				MAY
JUN											3	18	28	83	126	153	202	196	107	55	28		JUN
JUL														11	18	48	114	190	242	264	103	11	JUL
AUG													3	29	46	65	114	192	225	215	107	3	AUG
SEP										7	7	24	71	67	84	141	182	219	131	57	10		SEP
OCT							3		15	49	79	131	168	119	165	98	131	37	6				OCT
NOV						10	35	94	202	202	213	98	101	42	3								NOV
DEC		10	10	20	27	37	110	196	276	193	93	23	7										DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 105897 MIDDLE FORK LODGE 1971-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	330	80	130	120	140	100	80	20															JAN 1
JAN 11	100	50	110	180	90	160	200	110															JAN 11
JAN 21	147	92	183	165	128	119	119	46															JAN 21
FEB 1	133	22	300	122	144	167	89	22															FEB 1
FEB 11		33	111	100	278	233	122	122															FEB 11
FEB 21	14	81	108	95	243	162	257	41															FEB 21
MAR 1	20	10	30	90	160	290	290	100	10														MAR 1
MAR 11				70	200	340	250	110	30														MAR 11
MAR 21		19		46	130	296	361	139	9														MAR 21
APR 1				29	76	162	467	238	29														APR 1
APR 11					36	218	436	255	45	9													APR 11
APR 21						46	284	376	202	92													APR 21
MAY 1						20	200	440	290	50													MAY 1
MAY 11						20	120	370	360	120	10												MAY 11
MAY 21							127	245	345	218	64												MAY 21
JUN 1						9	56	224	271	262	121	47	9										JUN 1
JUN 11							9	128	321	349	165	28											JUN 11
JUN 21							9	45	236	355	300	55											JUN 21
JUL 1								68	182	284	352	114											JUL 1
JUL 11								11	67	344	367	122	67	11	11								JUL 11
JUL 21									11	179	632	147	32										JUL 21
AUG 1									71	293	455	152	30										AUG 1
AUG 11								40	192	283	394	61	30										AUG 11
AUG 21								128	211	440	193	28											AUG 21
SEP 1							40	220	330	320	60	30											SEP 1
SEP 11						40	71	232	364	222	40	30											SEP 11
SEP 21						51	214	286	388	41	20												SEP 21
OCT 1					10	105	295	419	152	19													OCT 1
OCT 11					20	127	324	324	147	59													OCT 11
OCT 21		17		17	75	267	350	225	42	8													OCT 21
NOV 1			32	32	181	191	287	202	53	21													NOV 1
NOV 11		11	43	129	140	194	312	151	22														NOV 11
NOV 21	30	40	90	150	280	280	90	40															NOV 21
DEC 1	120	20	80	160	170	170	190	90															DEC 1
DEC 11	86	32	108	312	172	151	97	43															DEC 11
DEC 21	56	102	130	231	93	167	120	102															DEC 21
MONTH																							MONTH
JAN	191	74	142	155	120	126	133	58															JAN
FEB	51	43	177	106	220	189	150	63															FEB
MAR	6	10	10	68	162	308	302	117	16														MAR
APR				9	37	142	395	290	93	34													APR
MAY						13	148	348	332	132	26												MAY
JUN						3	25	132	276	322	196	43	3										JUN
JUL								26	84	267	454	128	33	4	4								JUL
AUG								59	160	342	342	78	20										AUG
SEP						30	108	246	360	195	40	20											SEP
OCT		6		6	37	171	324	318	110	28													OCT
NOV	10	17	56	105	202	223	226	129	24	7													NOV
DEC	86	53	106	233	143	163	136	80															DEC

(con.)

Table 22 (Con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 107706 RIGGINS 1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1				4	11	56	56	123	239	257	151	70	28	4									JAN 1
JAN 11					4	11	25	86	179	264	229	168	32	4									JAN 11
JAN 21				3	3	23	49	111	134	207	285	128	46	10									JAN 21
FEB 1						7	25	21	79	168	279	261	111	36	14								FEB 1
FEB 11							7	11	60	158	208	324	169	56	4	4							FEB 11
FEB 21						14	9	14	36	90	158	293	203	126	59								FEB 21
MAR 1								4	16	166	190	229	217	111	40	20	8						MAR 1
MAR 11								4	15	38	153	238	211	199	100	19	23						MAR 11
MAR 21									7	37	67	180	223	183	147	87	47	23					MAR 21
APR 1										24	35	126	142	213	161	169	87	43					APR 1
APR 11										4	26	90	207	252	147	120	94	45	11	4			APR 11
APR 21										4	8	96	176	169	153	149	126	65	34	15	4		APR 21
MAY 1											27	51	75	116	157	222	140	140	48	17	7		MAY 1
MAY 11												17	61	136	105	156	210	119	139	47	10		MAY 11
MAY 21											3	9	46	68	117	218	154	169	108	80	28		MAY 21
JUN 1												3	17	60	81	158	148	195	158	141	34	7	JUN 1
JUN 11													10	31	78	122	166	159	214	122	81	17	JUN 11
JUN 21													3	17	41	88	145	159	206	172	105	64	JUN 21
JUL 1														3	10	30	93	157	153	230	227	97	JUL 1
JUL 11																13	10	103	180	220	260	213	JUL 11
JUL 21																6	15	33	61	230	391	264	JUL 21
AUG 1																	17	57	130	237	317	243	AUG 1
AUG 11														7	10	20	40	93	120	200	293	217	AUG 11
AUG 21														3	27	55	116	149	182	173	176	119	AUG 21
SEP 1													3	10	27	77	104	134	221	224	157	43	SEP 1
SEP 11													10	43	113	127	153	117	220	163	43	10	SEP 11
SEP 21												4	35	82	92	128	160	209	142	85	64		SEP 21
OCT 1												20	64	129	92	159	224	210	85	14	3		OCT 1
OCT 11												34	128	197	203	179	193	66					OCT 11
OCT 21									6	6	55	143	195	175	211	182	26						OCT 21
NOV 1									4	57	87	226	340	215	60	11							NOV 1
NOV 11					12	4	4	35	16	129	204	290	184	102	20								NOV 11
NOV 21							4	19	98	226	320	237	68	26	4								NOV 21
DEC 1				7	11	15	11	37	110	311	253	198	40	7									DEC 1
DEC 11				4	4	11	30	71	167	260	264	164	26										DEC 11
DEC 21				14		7	3	110	197	321	197	110	21	21									DEC 21
MONTH																							MONTH
JAN				2	6	30	44	107	183	242	223	122	36	6									JAN
FEB						6	14	15	60	142	219	293	158	69	23	1							FEB
MAR								2	12	77	133	214	217	166	98	44	27	9					MAR
APR										10	23	104	175	211	154	146	102	51	15	6	1		APR
MAY											10	25	60	105	126	199	168	143	99	49	15		MAY
JUN												1	10	36	66	123	153	171	192	145	73	29	JUN
JUL														1	3	16	39	96	129	227	296	194	JUL
AUG														3	13	26	59	101	145	202	259	191	AUG
SEP												1	16	44	77	110	138	152	195	159	89	18	SEP
OCT									2	2	19	67	130	167	169	174	146	91	28	4	1		OCT
NOV					4	1	3	18	39	137	204	251	197	115	28	4							NOV
DEC				8	5	11	14	73	159	298	237	156	29	10									DEC

(con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 107706 RIGGINS 1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	4	25	35	53	95	147	270	200	126	42	4												JAN 1
JAN 11	7	4	11	36	25	114	250	268	207	68	11												JAN 11
JAN 21	13	33	26	33	69	151	180	298	121	69	7												JAN 21
FEB 1		4	25	11	36	86	207	375	168	75	14												FEB 1
FEB 11	4			11	32	85	190	335	261	70	11	4											FEB 11
FEB 21		14	14	14	50	50	171	378	212	81	18												FEB 21
MAR 1					12	110	232	339	205	79	24												MAR 1
MAR 11				4	11	61	226	318	222	130	27												MAR 11
MAR 21					3	30	126	243	286	243	60	10											MAR 21
APR 1					4	11	53	200	366	287	72	8											APR 1
APR 11						4	54	225	344	250	105	18											APR 11
APR 21							26	125	314	299	155	77	4										APR 21
MAY 1								41	182	294	280	169	30	3									MAY 1
MAY 11								37	117	252	305	225	54	10									MAY 11
MAY 21								12	68	249	280	255	117	15	3								MAY 21
JUN 1								3	13	131	228	359	195	67	3								JUN 1
JUN 11										64	180	380	254	112	10								JUN 11
JUN 21									3	57	179	287	287	132	51	3							JUN 21
JUL 1										20	80	217	370	217	83	13							JUL 1
JUL 11											13	173	280	353	157	23							JUL 11
JUL 21											3	94	288	424	155	27	3						JUL 21
AUG 1											13	117	353	320	157	33	7						AUG 1
AUG 11										7	33	133	350	340	120	17							AUG 11
AUG 21										18	122	277	322	207	43	12							AUG 21
SEP 1										60	177	293	317	117	33	3							SEP 1
SEP 11								17	30	113	230	340	210	57	3								SEP 11
SEP 21								11	92	181	277	252	156	28	4								SEP 21
OCT 1							7	51	132	237	380	149	37	3	3								OCT 1
OCT 11						3	14	105	206	289	272	84	24	3									OCT 11
OCT 21					3	6	45	203	242	303	139	39	19										OCT 21
NOV 1						45	109	226	200	279	109	26	4										NOV 1
NOV 11	8		8	8	27	70	117	203	258	234	55	12											NOV 11
NOV 21			8	4	34	135	184	278	211	128	19												NOV 21
DEC 1	7	4	7	22	37	107	180	353	180	96	7												DEC 1
DEC 11	8	4	19	19	60	120	203	289	188	90													DEC 11
DEC 21	10	3		31	42	104	263	287	180	73	7												DEC 21
MONTH																							MONTH
JAN	8	21	24	40	63	138	232	256	151	60	7												JAN
FEB	1	5	13	11	38	75	191	361	214	75	14	1											FEB
MAR				1	9	65	191	297	240	156	38	4											MAR
APR					1	5	44	183	341	278	111	34	1										APR
MAY								29	121	264	288	218	69	10	1								MAY
JUN								1	6	84	196	342	245	103	21	1							JUN
JUL										6	33	159	312	334	132	22	1						JUL
AUG										9	58	179	341	286	104	20	2						AUG
SEP								9	40	117	227	296	229	68	14	1							SEP
OCT					1	3	22	121	194	277	261	90	27	2	1								OCT
NOV	3		5	4	20	84	137	236	222	213	61	13	1										NOV
DEC	8	4	8	24	46	110	216	310	183	86	5												DEC

(con.)

Table 22 (Con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 108076 SALMON - SALMON 1 N 1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	20	33	40	70	77	150	143	157	140	93	53	20	3										JAN 1
JAN 11	3	7	17	33	60	70	153	177	203	160	83	23	7	3									JAN 11
JAN 21	21	15	24	45	55	82	170	206	179	130	39	21	12										JAN 21
FEB 1	3	7	17	13	10	43	100	227	223	220	87	37	10	3									FEB 1
FEB 11				3	3	27	74	147	214	254	181	84	13										FEB 11
FEB 21				4	16	28	52	65	210	226	202	129	52	16									FEB 21
MAR 1				3	3	7	43	107	197	183	223	143	63	17	10								MAR 1
MAR 11							20	27	110	201	224	241	97	57	23								MAR 11
MAR 21							9	21	27	85	212	197	206	118	94	24	6						MAR 21
APR 1									10	43	114	214	237	147	140	60	27	7					APR 1
APR 11									7	17	103	153	203	210	133	93	63	7	10				APR 11
APR 21										33	97	123	157	193	127	127	80	43	20				APR 21
MAY 1									3		23	70	120	163	187	180	170	63	20				MAY 1
MAY 11										3	17	67	90	120	177	153	163	130	67	10	3		MAY 11
MAY 21											3	30	82	131	146	213	152	137	98	6			MAY 21
JUN 1												13	40	110	130	170	140	177	157	57	7		JUN 1
JUN 11													23	73	130	123	203	187	170	53	27	10	JUN 11
JUN 21												3	20	53	83	113	170	167	173	163	53		JUN 21
JUL 1													3	13	27	40	133	193	237	247	103	3	JUL 1
JUL 11															10	13	70	137	223	327	177	43	JUL 11
JUL 21																15	45	61	236	385	224	33	JUL 21
AUG 1																33	63	160	233	307	173	30	AUG 1
AUG 11													10	10	27	37	77	137	233	317	150	3	AUG 11
AUG 21													9	12	76	109	164	188	224	155	55	9	AUG 21
SEP 1													3	37	53	117	193	223	250	107	17		SEP 1
SEP 11										3	7	27	60	110	127	117	193	183	163	10			SEP 11
SEP 21											10	60	74	104	130	184	197	174	60	7			SEP 21
OCT 1										3	20	53	127	143	143	223	203	77	7				OCT 1
OCT 11										10	57	117	157	203	217	177	63						OCT 11
OCT 21								9	15	79	158	191	197	230	97	18	6						OCT 21
NOV 1							7	17	57	153	283	247	170	57	10								NOV 1
NOV 11			3	7		13	27	107	137	253	230	120	70	23	10								NOV 11
NOV 21				7	7	40	60	190	240	220	127	63	37	10									NOV 21
DEC 1		13	7	20	10	27	100	217	310	147	100	47	3										DEC 1
DEC 11	3	3	7	27	33	90	157	223	273	123	40	20											DEC 11
DEC 21	6	6	6	12	52	106	203	230	185	139	42	9	3										DEC 21
MONTH																							MONTH
JAN	15	18	27	49	63	100	156	181	174	128	58	22	8	1									JAN
FEB	1	2	6	7	9	33	77	151	216	234	153	80	24	6									FEB
MAR				1	1	2	24	51	109	154	220	194	125	66	44	9	2						MAR
APR									6	31	105	164	199	184	133	93	57	19	10				APR
MAY									1	1	14	55	97	138	169	183	162	111	63	5	1		MAY
JUN												6	28	79	114	136	171	177	167	91	29	3	JUN
JUL													1	4	12	23	82	128	232	322	170	27	JUL
AUG													6	8	35	61	103	162	230	256	124	14	AUG
SEP										1	6	29	46	83	103	139	195	194	158	41	6		SEP
OCT								3	5	32	81	123	161	194	151	135	88	25	2				OCT
NOV			1	4	2	18	31	104	144	209	213	143	92	30	7								NOV
DEC	3	8	6	19	32	75	155	224	254	137	60	25	2										DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 108076 SALMON - SALMON 1 N 1951-1980

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	319	84	148	144	111	97	60	30	7														JAN 1
JAN 11	160	93	147	127	133	110	110	100	20														JAN 11
JAN 21	242	88	142	158	103	85	85	88	9														JAN 21
FEB 1	110	110	134	124	144	174	137	67															FEB 1
FEB 11	47	77	77	100	177	214	201	97	10														FEB 11
FEB 21	69	40	69	101	165	222	206	125	4														FEB 21
MAR 1	37	17	74	94	191	244	207	114	23														MAR 1
MAR 11	7	23	27	83	187	280	240	110	43														MAR 11
MAR 21			18	27	118	279	288	182	73	15													MAR 21
APR 1				17	50	207	278	291	100	54	3												APR 1
APR 11				3	57	190	257	270	157	63	3												APR 11
APR 21					13	60	217	343	213	113	40												APR 21
MAY 1					10	37	127	220	270	243	83	10											MAY 1
MAY 11						3	67	213	337	273	80	27											MAY 11
MAY 21							30	148	273	300	200	42	6										MAY 21
JUN 1							17	57	157	337	273	133	27										JUN 1
JUN 11							3	30	100	290	383	173	20										JUN 11
JUN 21								30	90	277	350	170	73	10									JUN 21
JUL 1							3	7	73	210	370	223	100	13									JUL 1
JUL 11									10	130	343	343	127	47									JUL 11
JUL 21								6	6	103	334	389	134	24	3								JUL 21
AUG 1									17	207	327	273	133	40	3								AUG 1
AUG 11								7	30	214	445	211	77	17									AUG 11
AUG 21							3	24	170	288	330	155	24		3	3							AUG 21
SEP 1							23	120	243	290	213	67	40	3									SEP 1
SEP 11					7	3	73	130	313	290	143	33	7										SEP 11
SEP 21						33	127	237	341	164	77	20											SEP 21
OCT 1					10	103	270	287	173	110	37	10											OCT 1
OCT 11				7	73	140	303	213	157	80	23	3											OCT 11
OCT 21		3	3	21	127	245	279	179	100	39	3												OCT 21
NOV 1		3	23	113	180	247	173	160	77	23													NOV 1
NOV 11	13	27	80	93	157	167	213	197	43	10													NOV 11
NOV 21	40	20	130	140	177	187	197	97	13														NOV 21
DEC 1	70	50	110	180	203	167	133	80	7														DEC 1
DEC 11	110	80	103	147	210	180	103	67															DEC 11
DEC 21	97	145	152	164	185	94	82	67	12	3													DEC 21
MONTH																							MONTH
JAN	240	88	145	143	115	97	85	73	12														JAN
FEB	76	78	95	109	162	202	180	95	5														FEB
MAR	14	13	39	67	164	268	247	137	47	5													MAR
APR				7	40	152	250	301	157	77	16												APR
MAY					3	13	73	192	292	273	124	27	2										MAY
JUN							7	39	116	301	336	159	40	3									JUN
JUL							1	4	29	146	349	321	121	28	1								JUL
AUG							1	11	75	238	366	211	76	18	2	1							AUG
SEP					2	12	75	162	299	248	145	40	16	1									SEP
OCT		1	1	10	72	166	284	225	142	75	20	4											OCT
NOV	18	17	78	116	171	200	194	151	44	11													NOV
DEC	92	94	123	163	199	145	105	71	6	1													DEC

(con.)

Table 22 (Con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 108395 SHOUP 1966-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	25		81	69	113	88	163	188	206	56	13												JAN 1
JAN 11				6	31	56	138	219	344	169	38												JAN 11
JAN 21			23	23	45	85	136	239	256	153	34	6											JAN 21
FEB 1				31	19	25	44	169	363	250	94	6											FEB 1
FEB 11							31	150	238	325	175	63	19										FEB 11
FEB 21								53	152	280	333	144	38										FEB 21
MAR 1							6	75	125	225	225	213	94	38									MAR 1
MAR 11									25	150	263	306	175	56	25								MAR 11
MAR 21								6	23	80	200	251	177	109	97	51	6						MAR 21
APR 1									6	25	150	150	250	200	100	69	44	6					APR 1
APR 11										31	75	206	231	138	188	94	19	19					APR 11
APR 21										13	31	169	175	144	163	144	94	44	25				APR 21
MAY 1											19	38	106	150	244	138	200	75	25	6			MAY 1
MAY 11											6	56	100	100	188	188	150	175	38				MAY 11
MAY 21												11	68	97	188	159	205	165	97	11			MAY 21
JUN 1													13	69	138	163	206	188	163	44	19		JUN 1
JUN 11													19	63	150	75	231	206	144	63	50		JUN 11
JUN 21													13	31	94	88	106	188	206	231	44		JUN 21
JUL 1															53	13	87	240	220	273	113		JUL 1
JUL 11															13		27	120	307	307	207	20	JUL 11
JUL 21																18	18	73	145	503	230	12	JUL 21
AUG 1																19	50	94	206	394	225	13	AUG 1
AUG 11													13	19	44	56	69	113	225	231	225	6	AUG 11
AUG 21														6	45	63	165	176	284	148	108	6	AUG 21
SEP 1													6	19	50	119	119	250	244	181	13		SEP 1
SEP 11											6	13	31	125	156	138	181	206	81	63			SEP 11
SEP 21											6	50	63	119	163	194	219	119	69				SEP 21
OCT 1											6	100	119	219	194	194	150	19					OCT 1
OCT 11										13	38	184	234	222	222	76	13						OCT 11
OCT 21								11	17	91	160	280	257	149	29	6							OCT 21
NOV 1								13	56	206	406	269	31	19									NOV 1
NOV 11						6	13	63	213	400	181	94	31										NOV 11
NOV 21				6	6	19	69	270	371	176	75	6											NOV 21
DEC 1		6	19	25	6	19	100	331	331	119	31	13											DEC 1
DEC 11			6	19	56	63	200	250	319	81	6												DEC 11
DEC 21	11			17	40	131	199	227	313	57	6												DEC 21
MONTH																							MONTH
JAN	8		34	32	63	77	145	216	268	127	28	2											JAN
FEB				11	7	9	27	128	257	285	192	66	18										FEB
MAR							2	26	57	149	228	257	149	69	42	18	2						MAR
APR									2	23	85	175	219	160	150	102	52	23	8				APR
MAY											8	34	91	115	206	161	185	139	54	6			MAY
JUN													15	54	127	108	181	194	171	113	38		JUN
JUL															22	11	43	142	222	366	185	11	JUL
AUG													4	8	30	46	97	129	240	254	183	8	AUG
SEP											4	21	33	88	123	150	173	192	131	81	4		SEP
OCT								4	6	37	71	191	205	195	144	89	53	6					OCT
NOV				2	2	8	27	115	213	261	221	123	21	6									NOV
DEC	4	2	8	20	34	73	167	268	321	85	14	4											DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 108395 SHOUP 1966-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	219	69	88	131	131	156	144	63															JAN 1
JAN 11	31	25	81	81	206	119	231	225															JAN 11
JAN 21	102	63	125	125	148	125	148	148	17														JAN 21
FEB 1	63	31	106	169	131	231	175	94															FEB 1
FEB 11			44	131	125	250	231	213	6														FEB 11
FEB 21			30	83	136	189	333	220	8														FEB 21
MAR 1		13	38	56	94	188	306	275	31														MAR 1
MAR 11			6	13	63	225	319	325	50														MAR 11
MAR 21			6		17	149	383	326	109	11													MAR 21
APR 1					13	63	306	381	169	63	6												APR 1
APR 11						56	244	381	238	69	6	6											APR 11
APR 21						13	69	344	338	206	31												APR 21
MAY 1						6	50	200	356	281	94	13											MAY 1
MAY 11							19	188	350	338	94	13											MAY 11
MAY 21							6	97	261	369	227	40											MAY 21
JUN 1								44	131	331	331	125	25	6	6								JUN 1
JUN 11								6	94	294	413	175	19										JUN 11
JUN 21								6	50	188	394	281	75	6									JUN 21
JUL 1									13	147	293	400	133	13									JUL 1
JUL 11										40	227	460	220	53									JUL 11
JUL 21										24	139	612	182	30	6	6							JUL 21
AUG 1										50	256	463	188	44									AUG 1
AUG 11									6	75	294	481	144										AUG 11
AUG 21									11	188	466	256	63	17									AUG 21
SEP 1								13	125	306	331	200	19	6									SEP 1
SEP 11							13	100	200	313	288	81	6										SEP 11
SEP 21							31	125	338	363	119	25											SEP 21
OCT 1							113	294	406	138	44	6											OCT 1
OCT 11					13	32	209	373	203	133	38												OCT 11
OCT 21			6	6	17	80	286	337	223	34	11												OCT 21
NOV 1				19	31	144	344	313	125	25													NOV 1
NOV 11		6	6	13	150	181	250	275	100	19													NOV 11
NOV 21	6	19	25	94	164	245	239	201	6														NOV 21
DEC 1	56	19	19	125	144	225	244	169															DEC 1
DEC 11	63	19	69	138	181	256	175	100															DEC 11
DEC 21	28	34	108	188	142	182	148	170															DEC 21
MONTH																							MONTH
JAN	117	52	99	113	161	133	173	145	6														JAN
FEB	22	11	62	131	131	226	241	173	4														FEB
MAR		4	16	22	57	186	337	309	65	4													MAR
APR					4	44	206	369	248	113	15	2											APR
MAY						2	24	159	321	331	141	22											MAY
JUN								19	92	271	379	194	40	4	2								JUN
JUL									4	69	217	495	178	32	2	2							JUL
AUG									6	107	343	395	129	20									AUG
SEP							15	79	221	327	246	102	8	2									SEP
OCT			2	2	10	39	205	335	276	99	30	2											OCT
NOV	2	8	10	42	115	190	278	263	77	15													NOV
DEC	48	24	67	151	155	220	188	147															DEC

(con.)

MAXIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 109560 WARREN 1960-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1			9	50	91	136	200	223	200	82	9												JAN 1
JAN 11			5	14	14	91	141	214	314	150	55	5											JAN 11
JAN 21			4	4	37	108	137	232	266	154	46	12											JAN 21
FEB 1					14	27	73	159	255	264	164	32	14										FEB 1
FEB 11						14	68	214	327	245	86	36	9										FEB 11
FEB 21			5	5	16	44	49	137	236	198	236	60	11										FEB 21
MAR 1						32	82	145	259	245	159	59	14	5									MAR 1
MAR 11						5	50	164	182	273	177	86	55		9								MAR 11
MAR 21						12	29	62	248	248	128	136	79	50	8								MAR 21
APR 1							9	45	159	259	209	141	109	55	14								APR 1
APR 11								45	141	255	200	118	145	55	36	5							APR 11
APR 21								27	86	182	236	118	155	105	59	23	9						APR 21
MAY 1								19	33	126	140	195	167	153	107	37	23						MAY 1
MAY 11									18	132	77	123	145	191	200	86	27						MAY 11
MAY 21									8	42	59	152	165	156	215	139	46	17					MAY 21
JUN 1										5	38	99	122	146	225	235	94	33	5				JUN 1
JUN 11										9	32	82	123	105	236	164	150	59	41				JUN 11
JUN 21											27	82	59	82	168	186	200	164	32				JUN 21
JUL 1													18	51	111	189	336	226	65	5			JUL 1
JUL 11													14	18	64	193	294	289	119	9			JUL 11
JUL 21												4	4	4	37	74	318	430	112	17			JUL 21
AUG 1													9	9	41	127	286	395	105	27			AUG 1
AUG 11											5	18	32	45	73	155	245	300	127				AUG 11
AUG 21											12	17	70	91	153	215	211	169	54	8			AUG 21
SEP 1									5		9	14	73	105	151	242	256	137	9				SEP 1
SEP 11									14	14	27	127	95	141	191	200	114	64	14				SEP 11
SEP 21									5	64	64	55	100	155	164	209	127	59					SEP 21
OCT 1									23	64	69	110	128	138	193	147	128						OCT 1
OCT 11								5	42	88	139	130	144	222	144	69	19						OCT 11
OCT 21							8	29	105	122	185	193	176	97	71	13							OCT 21
NOV 1						5	9	64	182	273	127	168	109	45	18								NOV 1
NOV 11					9	18	50	123	309	214	200	59	18										NOV 11
NOV 21					5	32	95	264	336	205	59	5											NOV 21
DEC 1			14	27	27	36	136	245	268	173	68	5											DEC 1
DEC 11	5			23	23	118	168	209	268	164	18		5										DEC 11
DEC 21		4	12		29	99	227	289	240	79	21												DEC 21

MONTH	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	MONTH
JAN			6	22	47	112	159	223	260	129	37	6											JAN
FEB			2	2	10	27	64	172	275	238	158	42	11										FEB
MAR						16	53	122	230	255	154	95	50	19	6								MAR
APR							3	39	129	232	215	126	136	71	36	9	3						APR
MAY								6	19	98	91	156	159	167	176	89	33	6					MAY
JUN										5	32	87	101	110	210	194	149	86	26				JUN
JUL												1	12	24	69	149	316	319	99	10			JUL
AUG											6	12	38	50	91	167	246	284	94	12			AUG
SEP									8	26	33	65	90	134	168	217	165	86	8				SEP
OCT							3	12	58	92	132	146	150	150	134	74	48						OCT
NOV					5	18	52	150	276	230	129	77	42	15	6								NOV
DEC	1	1	9	16	26	85	179	249	258	136	35	1	1										DEC

(con.)

Table 22 (Con.)

MINIMUM DAILY TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 109560 WARREN 1960-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JAN 1	386	91	136	105	123	91	55	14															JAN 1
JAN 11	250	114	86	132	132	91	127	68															JAN 11
JAN 21	344	95	154	83	149	71	71	33															JAN 21
FEB 1	268	105	109	145	141	123	82	27															FEB 1
FEB 11	164	55	142	132	192	178	91	46															FEB 11
FEB 21	258	88	187	154	88	126	71	27															FEB 21
MAR 1	232	77	136	195	136	123	77	23															MAR 1
MAR 11	199	93	130	171	157	130	106	14															MAR 11
MAR 21	91	99	120	149	178	198	120	45															MAR 21
APR 1	23	27	86	191	205	264	159	45															APR 1
APR 11	23	55	73	155	205	236	214	36	5														APR 11
APR 21		5	18	77	191	309	305	86	9														APR 21
MAY 1		5	14	23	98	260	353	223	23														MAY 1
MAY 11				32	50	264	377	232	45														MAY 11
MAY 21				4	34	156	376	300	101	30													MAY 21
JUN 1					9	94	296	305	216	61	14		5										JUN 1
JUN 11						27	191	359	300	109	14												JUN 11
JUN 21						41	209	314	291	114	27	5											JUN 21
JUL 1						23	138	318	318	147	46	9											JUL 1
JUL 11						18	101	349	317	147	32	32	5										JUL 11
JUL 21						12	83	335	339	153	54	25											JUL 21
AUG 1						5	123	436	264	114	45	14											AUG 1
AUG 11						9	164	391	264	127	36	9											AUG 11
AUG 21					8	66	269	343	227	70	17												AUG 21
SEP 1					32	146	297	311	142	27	46												SEP 1
SEP 11			9	18	68	155	323	227	150	45	5												SEP 11
SEP 21				5	86	218	368	223	86	9	5												SEP 21
OCT 1			5	41	134	318	327	115	51	9													OCT 1
OCT 11		9	19	93	98	391	247	107	33	5													OCT 11
OCT 21	13	17	42	92	209	272	251	100	4														OCT 21
NOV 1	23	27	82	141	200	205	209	109	5														NOV 1
NOV 11	82	64	68	118	173	227	191	73	5														NOV 11
NOV 21	118	145	150	164	145	114	136	27															NOV 21
DEC 1	177	109	132	141	150	145	95	50															DEC 1
DEC 11	232	118	136	127	145	109	100	32															DEC 11
DEC 21	244	107	136	149	140	124	62	37															DEC 21
MONTH																							MONTH
JAN	327	100	126	106	135	84	84	38															JAN
FEB	229	82	143	143	143	143	82	34															FEB
MAR	171	90	128	171	158	152	102	28															MAR
APR	15	29	59	141	200	270	226	56	5														APR
MAY		1	4	19	60	225	369	253	58	10													MAY
JUN					3	54	231	326	270	95	18	2	2										JUN
JUL						18	106	334	325	149	44	22	1										JUL
AUG					3	28	188	389	251	103	32	7											AUG
SEP			3	8	62	173	329	253	126	27	18												SEP
OCT	4	9	22	76	149	325	274	107	28	4													OCT
NOV	74	79	100	141	173	182	179	70	3														NOV
DEC	218	111	135	139	145	126	85	40															DEC

Table 23—Mean temperature statistics; based on arithmetic average of daily maximum and minimum temperatures (table 21)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 100835 BIG CREEK 1 S — 1949-1967

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
JAN 1	16	18.9	5.6	18.5	27.8 53	10.9 58	38 53	31.1	6.2	33.0	-14 59	3.8	9.2	1.0	JAN 1
JAN 11	16	19.9	8.0	19.5	33.4 53	5.1 60	42 53	31.1	6.9	30.0	-12 63	5.4	10.0	5.5	JAN 11
JAN 21	17	19.8	6.4	21.0	31.3 53	5.0 57	39 60	32.7	5.0	34.0	-15 62	3.9	10.6	7.0	JAN 21
FEB 1	18	23.2	6.5	24.0	34.9 63	11.5 56	42 63	33.1	4.7	34.0	-12 56	10.8	10.1	13.0	FEB 1
FEB 11	17	24.0	5.0	21.0	30.8 58	16.1 55	40 58	34.3	3.6	34.0	-10 56	10.7	10.1	10.0	FEB 11
FEB 21	17	24.0	7.6	26.0	31.9 63	7.9 60	43 54	33.9	5.7	35.0	-11 62	13.2	10.2	18.0	FEB 21
MAR 1	17	23.9	3.3	23.0	30.4 57	19.4 52	40 60	34.7	3.7	35.0	-4 55	10.9	6.7	11.0	MAR 1
MAR 11	17	26.0	4.3	26.0	34.6 49	18.1 65	41 61	35.1	3.9	35.0	0 65	11.9	7.4	12.0	MAR 11
MAR 21	17	30.9	4.1	30.0	36.9 63	23.2 55	44 62	38.9	3.1	39.0	4 65	21.1	7.5	22.0	MAR 21
APR 1	17	33.9	2.8	34.0	40.9 60	28.7 53	45 60	39.9	2.2	39.0	20 52	26.3	3.5	28.0	APR 1
APR 11	18	35.9	3.4	34.5	43.6 62	30.2 55	50 62	42.0	3.1	42.5	21 67	27.5	5.0	27.0	APR 11
APR 21	18	37.9	3.3	38.0	43.4 52	30.5 67	49 59	43.9	4.1	45.0	25 67	30.3	3.4	30.5	APR 21
MAY 1	18	41.5	4.3	41.0	51.5 66	35.3 50	55 66	47.7	4.5	48.0	24 67	34.4	6.0	35.0	MAY 1
MAY 11	17	45.1	2.9	44.0	50.8 54	41.1 67	57 58	51.1	3.8	51.0	29 67	36.8	3.6	37.0	MAY 11
MAY 21	18	47.3	4.1	46.0	55.5 58	41.2 59	60 66	53.8	4.2	53.5	30 60	40.1	4.8	41.0	MAY 21
JUN 1	18	49.7	3.5	48.0	57.2 52	43.9 54	62 52	55.2	4.1	54.0	34 55	42.4	4.7	43.0	JUN 1
JUN 11	18	51.3	3.4	50.0	59.4 61	46.8 54	66 61	56.9	3.5	56.5	38 65	44.2	4.4	44.0	JUN 11
JUN 21	18	53.0	2.6	52.5	58.4 61	48.6 63	66 54	60.2	3.3	60.5	41 66	45.4	3.0	45.0	JUN 21
JUL 1	18	56.3	2.7	56.5	60.2 50	48.9 55	67 54	61.7	2.8	62.5	42 55	49.7	3.7	51.0	JUL 1
JUL 11	18	59.2	3.1	59.5	63.8 55	53.0 63	70 55	63.5	3.7	63.5	45 63	53.6	3.7	53.5	JUL 11
JUL 21	18	59.6	2.4	59.0	65.0 60	55.0 63	71 59	65.3	3.6	65.0	45 50	53.1	4.1	53.5	JUL 21
AUG 1	19	59.0	2.8	59.0	64.1 61	53.2 56	69 52	64.1	3.1	64.0	47 56	53.9	3.2	55.0	AUG 1
AUG 11	19	58.2	2.5	58.0	63.6 58	53.0 54	69 61	62.8	3.0	62.0	44 64	52.9	3.8	54.0	AUG 11
AUG 21	19	54.1	3.5	53.0	61.0 67	48.7 60	68 67	60.1	3.9	60.0	36 60	46.6	5.4	46.0	AUG 21
SEP 1	17	52.8	3.7	51.0	60.8 67 M	47.1 64	65 67	58.1	3.8	58.0	39 57	46.4	4.4	47.0	SEP 1
SEP 11	16	49.3	3.3	49.0	53.8 53	39.8 65	60 59	55.4	3.3	56.5	29 65	40.8	4.5	41.0	SEP 11
SEP 21	17	47.4	5.1	47.0	57.1 67	37.9 61	60 66	51.7	5.2	52.0	31 55	40.6	6.3	40.0	SEP 21
OCT 1	16	44.6	3.3	44.0	51.1 63	39.3 57	58 63	50.8	2.8	50.5	28 61	37.2	5.4	36.0	OCT 1
OCT 11	16	41.7	3.3	41.5	46.1 63	34.7 66	53 53	47.5	3.6	46.5	26 66	33.5	4.1	33.0	OCT 11
OCT 21	16	36.7	3.4	36.0	41.7 65	30.5 56	51 59	43.9	3.4	44.0	21 51	28.4	5.1	28.5	OCT 21
NOV 1	17	31.9	3.9	31.0	38.4 65	26.2 56	48 54	39.2	3.8	40.0	9 56	22.2	6.5	20.0	NOV 1
NOV 11	17	28.6	6.6	29.0	39.6 54	14.4 55	47 54	38.9	3.9	38.0	-10 55	15.8	11.8	18.0	NOV 11
NOV 21	17	25.6	5.0	26.0	33.1 53	11.1 52	51 65	36.9	6.4	37.0	2 52	13.1	6.1	13.0	NOV 21
DEC 1	18	22.3	4.1	21.0	30.9 58	15.8 60	40 65	32.9	3.7	32.0	-4 61	8.2	7.7	8.5	DEC 1
DEC 11	16	21.7	5.7	23.5	27.4 62	10.0 64	36 62	32.2	3.9	33.5	-21 64	5.6	10.3	10.0	DEC 11
DEC 21	16	19.5	3.9	19.0	26.4 64	13.7 52	38 64	31.0	4.2	30.0	-6 51	4.9	5.9	6.0	DEC 21
MONTH															MONTH
JAN	16	19.5	4.9	18.0	30.9 53	10.9 57	42 53	36.0	3.4	36.5	-15 62	-3.7	9.3	-0.5	JAN
FEB	17	23.6	4.2	23.0	31.8 63	17.0 55	43 54	37.2	2.8	36.0	-12 56	4.4	9.9	4.0	FEB
MAR	17	27.0	2.8	27.0	30.4 53	21.0 55	44 62	39.9	2.0	40.0	-4 55	8.5	5.9	9.0	MAR
APR	17	36.1	1.9	36.0	39.1 49	31.9 55	50 62	45.5	2.5	45.0	20 52	24.5	3.2	24.0	APR
MAY	17	44.4	2.8	43.0	50.2 58	40.5 59	60 66	54.1	3.3	54.0	24 67	32.4	4.5	33.0	MAY
JUN	18	51.4	1.9	51.0	57.3 61	48.4 53	66 61	61.1	2.8	61.5	34 55	40.5	3.6	40.0	JUN
JUL	18	58.4	1.6	58.0	61.9 60	55.2 63	71 59	66.6	3.0	67.0	42 55	48.5	3.6	48.0	JUL
AUG	19	57.0	2.2	56.0	61.6 61	54.0 54	69 61	65.3	2.6	65.0	36 60	46.3	4.9	46.0	AUG
SEP	16	49.5	2.8	49.0	54.4 63	44.5 65	65 67	58.1	3.3	58.5	29 65	37.3	4.1	38.0	SEP
OCT	16	40.9	2.0	40.0	44.3 63	38.5 61	58 63	51.3	2.4	51.0	21 51	27.6	4.3	28.0	OCT
NOV	17	28.7	3.5	29.0	35.8 54	23.6 52	51 65	41.4	4.0	41.0	-10 55	7.7	6.9	8.0	NOV
DEC	16	21.0	2.8	20.0	27.9 58	17.1 54	40 65	35.0	2.6	34.5	-21 64	-1.1	7.2	0.5	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101663 CHALLIS 1951-1980

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
JAN 1	30	17.3	8.8	18.0	30.8 69	-5.9 74	45 69	29.2	8.6	30.0	-13 79	5.1	9.3	5.0	JAN 1
JAN 11	30	22.9	7.5	24.0	38.2 53	8.1 60	46 53	33.5	7.0	34.0	-14 63	10.3	10.1	10.5	JAN 11
JAN 21	30	20.9	7.9	21.0	35.6 53	3.9 57	47 71	32.8	7.4	31.0	-17 62	7.6	11.4	11.0	JAN 21
FEB 1	30	24.9	6.9	24.5	40.7 63	3.6 56	47 63	34.4	6.3	34.0	-16 56	14.3	10.9	17.0	FEB 1
FEB 11	29	28.3	5.4	28.0	37.1 77	15.7 52	47 70	37.7	5.3	39.0	1 56	19.0	7.1	20.0	FEB 11
FEB 21	29	28.5	7.5	29.0	38.8 54	9.9 60	48 54	36.9	6.0	38.0	-3 60	20.9	9.3	22.0	FEB 21
MAR 1	30	30.0	5.3	30.0	40.1 68	18.9 52	48 72	38.9	5.4	38.5	-2 60	20.2	8.2	22.0	MAR 1
MAR 11	30	32.9	4.5	31.5	44.8 72	26.3 52	49 72	40.6	4.1	40.0	12 51	23.5	6.9	23.5	MAR 11
MAR 21	30	38.1	4.5	37.0	48.3 78	27.0 75	55 68	45.5	4.7	45.0	16 75	29.1	6.0	29.0	MAR 21
APR 1	29	41.6	3.9	42.0	50.4 60	31.1 75	55 77	48.3	4.7	49.0	24 75	33.2	3.9	34.0	APR 1
APR 11	30	43.6	3.9	42.5	54.3 62	35.9 70	63 62	50.9	4.4	51.0	25 66	35.0	5.1	34.0	APR 11
APR 21	30	46.3	4.4	45.5	57.7 77	38.4 75	62 77	53.6	4.8	54.0	31 67	38.5	4.9	37.0	APR 21
MAY 1	30	50.5	4.3	51.0	61.7 66	42.4 75 M	66 66	57.6	4.2	58.0	30 54	41.9	5.9	43.0	MAY 1
MAY 11	30	52.6	4.2	52.0	61.5 54	42.3 74	71 54	60.6	4.4	60.5	36 74	43.3	4.7	43.0	MAY 11
MAY 21	29	55.3	4.3	54.0	63.9 58	47.9 59 M	70 66	63.2	3.9	63.0	39 78	46.6	5.2	45.0	MAY 21
JUN 1	30	58.5	4.9	57.5	67.6 72	47.4 51	73 77	65.1	4.2	65.0	40 51	51.2	5.5	50.5	JUN 1
JUN 11	30	60.7	4.1	61.0	71.4 74	54.0 76	75 74	67.2	3.8	67.0	43 73	53.0	5.0	53.0	JUN 11
JUN 21	30	63.0	4.4	62.5	71.5 61	52.9 69	78 70	70.5	3.9	71.0	45 69	53.9	5.1	54.0	JUN 21
JUL 1	30	66.4	3.9	67.5	73.3 75	56.0 55	80 60	72.3	3.9	72.5	47 55	58.4	5.0	59.0	JUL 1
JUL 11	30	69.5	2.4	69.5	74.0 59	64.4 52	79 60	74.3	2.6	74.0	56 80	62.9	4.1	63.0	JUL 11
JUL 21	30	70.1	2.2	69.5	75.0 60	66.2 51	80 60	75.0	2.6	75.0	55 72	63.6	4.2	64.5	JUL 21
AUG 1	29	68.5	3.4	69.0	75.2 61	61.1 76	81 61	73.3	3.4	72.0	51 74	62.8	4.7	63.0	AUG 1
AUG 11	29	66.9	4.1	68.0	72.9 61	58.1 68	80 69	72.5	3.7	72.0	47 74	60.2	6.0	63.0	AUG 11
AUG 21	29	63.3	4.1	62.0	70.9 67	57.2 65	81 61	69.9	4.5	70.0	46 60	55.4	5.0	55.0	AUG 21
SEP 1	30	61.6	2.9	61.0	67.4 67	55.6 64	74 67	68.1	3.1	67.5	46 76	53.1	4.0	53.5	SEP 1
SEP 11	30	56.9	3.8	56.5	62.4 56	46.4 78	73 66	64.4	3.8	64.0	30 65	47.9	6.1	48.0	SEP 11
SEP 21	30	54.4	4.8	54.0	63.9 67	45.3 61	71 66	60.4	4.0	60.5	37 71	46.0	5.9	46.5	SEP 21
OCT 1	30	51.5	3.9	51.5	60.4 63	43.8 77	67 63	58.5	3.3	58.0	35 59	42.5	5.0	42.0	OCT 1
OCT 11	28	47.4	3.6	47.5	52.9 58	35.9 69	61 64	55.4	4.2	57.0	26 69	38.6	4.7	38.0	OCT 11
OCT 21	29	41.8	3.9	42.0	48.3 62	35.4 70	59 59	50.2	4.7	50.0	14 71	33.0	5.9	34.0	OCT 21
NOV 1	29	37.1	4.5	37.0	47.6 65	31.1 73	57 58	45.2	4.9	45.0	19 78	28.4	6.9	29.0	NOV 1
NOV 11	29	32.2	5.4	33.0	42.9 54	18.1 55	51 54	41.9	4.1	41.0	0 55	22.5	8.1	23.0	NOV 11
NOV 21	29	28.0	5.2	28.0	37.2 53	14.6 52	51 60	38.2	5.7	39.0	1 79	17.4	7.4	19.0	NOV 21
DEC 1	29	25.7	4.0	24.0	35.1 75	18.1 78	47 51	35.1	4.9	36.0	-9 72	15.0	7.1	17.0	DEC 1
DEC 11	28	22.5	5.6	23.0	31.6 69	11.1 67	41 56	32.1	4.5	32.5	-6 64	12.1	7.9	14.5	DEC 11
DEC 21	28	21.4	5.1	20.0	37.2 80	14.0 52	46 80	32.8	5.3	31.5	-12 78	9.2	8.1	11.0	DEC 21
MONTH															MONTH
JAN	30	20.4	5.7	19.5	33.9 53	5.7 79	47 71	36.9	5.6	37.5	-17 62	-1.0	9.4	-1.0	JAN
FEB	28	27.3	4.8	27.0	37.7 63	16.8 56	48 54	40.3	4.5	40.5	-16 56	10.8	10.8	12.5	FEB
MAR	30	33.8	3.5	32.5	41.8 68	27.0 52	55 68	46.5	3.8	46.0	-2 60	18.5	7.2	17.5	MAR
APR	29	43.8	2.9	43.0	48.8 77	36.8 75	63 62	54.6	4.1	54.0	24 75	31.8	3.2	32.0	APR
MAY	29	53.0	3.0	53.0	59.0 69	47.4 59 M	71 54	64.3	3.2	64.0	30 54	39.5	4.0	39.0	MAY
JUN	30	60.7	2.8	60.0	66.2 61	55.1 51 M	78 70	71.3	2.8	71.0	40 51	48.3	3.8	48.0	JUN
JUL	30	68.7	1.9	68.5	73.0 60	65.7 55	80 60	76.3	1.9	76.0	47 55	57.3	4.4	57.0	JUL
AUG	29	66.1	3.1	65.0	72.3 61	61.0 76	81 61	74.5	3.0	74.0	46 60	54.7	5.1	53.0	AUG
SEP	30	57.6	2.9	57.0	62.6 66	51.3 65	74 67	68.6	3.0	68.5	30 65	43.7	5.1	45.0	SEP
OCT	28	46.7	2.4	46.0	51.8 63	42.0 69	67 63	59.3	2.7	59.0	14 71	31.8	5.2	32.5	OCT
NOV	28	32.5	3.4	32.5	38.3 65	26.8 79	57 58	46.2	4.9	45.0	0 55	14.6	6.5	17.0	NOV
DEC	26	23.2	3.2	22.5	29.8 80	16.9 78	47 51	37.6	4.2	37.0	-12 78	5.5	6.8	6.0	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101932 COBALT 1962-1981

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	20	14.6	8.9	15.5	26.1 66	-4.9 74	39 69	26.4	8.2	28.5	-19 79	1.3	10.3	3.0	JAN 1
JAN 11	20	21.1	7.0	22.5	30.6 67	2.1 63	42 71	31.9	6.5	32.5	-14 63	6.9	8.5	7.5	JAN 11
JAN 21	20	18.3	7.2	17.0	28.5 71	5.5 63	43 71	30.3	7.1	32.0	-11 62	5.1	8.6	6.5	JAN 21
FEB 1	20	22.7	4.5	21.5	29.6 78	14.5 76	40 67	33.4	4.1	34.5	-6 72	11.9	8.4	15.0	FEB 1
FEB 11	20	26.7	3.8	26.0	33.9 77	19.9 66	41 70	36.2	3.5	37.5	4 66	15.6	6.2	16.0	FEB 11
FEB 21	20	27.2	5.9	28.0	34.4 80	10.8 62	41 80	34.9	4.0	36.0	-3 62	18.8	8.4	21.0	FEB 21
MAR 1	19	28.8	4.7	28.0	36.4 68	21.6 69	44 68	37.2	4.5	38.0	8 76	19.5	7.7	18.0	MAR 1
MAR 11	19	30.8	4.5	30.0	39.8 72	22.4 65 M	44 81	39.2	3.4	40.0	9 65	22.2	6.6	21.0	MAR 11
MAR 21	19	33.9	4.5	33.0	44.4 78	25.3 75	50 78	42.1	3.9	42.0	12 75	23.8	6.6	24.0	MAR 21
APR 1	18	37.0	3.4	36.0	42.4 69	28.6 75	53 77	43.2	4.5	43.5	18 75	28.7	4.6	28.0	APR 1
APR 11	18	39.6	3.8	39.0	45.8 80	31.4 70	56 62	46.7	5.5	47.0	22 63	30.9	4.3	31.0	APR 11
APR 21	18	42.9	5.0	42.5	52.5 80	35.4 75	57 77	49.3	5.3	49.0	26 63	35.4	5.9	34.5	APR 21
MAY 1	17	46.6	2.8	45.0	53.4 80	41.8 75	58 80	52.4	2.9	53.0	30 68	37.6	4.5	37.0	MAY 1
MAY 11	17	48.2	4.1	47.0	55.5 73	38.1 74	61 76	55.0	4.7	56.0	33 74	40.1	3.8	40.0	MAY 11
MAY 21	17	50.8	3.0	50.0	55.8 69	47.0 75	68 81	59.5	3.4	58.0	37 73	42.4	4.0	42.0	MAY 21
JUN 1	17	54.4	4.1	53.0	62.9 77	47.6 62	69 77	60.4	4.1	61.0	40 73	47.1	4.8	47.0	JUN 1
JUN 11	17	56.0	3.8	56.0	66.7 74	51.5 81 M	72 74	62.4	3.7	62.0	41 73	48.6	4.7	48.0	JUN 11
JUN 21	17	58.7	4.2	58.0	64.1 73	49.6 69	72 70	65.5	3.7	66.0	43 75	50.5	5.7	51.0	JUN 21
JUL 1	17	61.5	3.5	62.0	67.7 75	56.1 62	73 73	66.7	3.1	66.0	51 71	54.9	3.3	54.0	JUL 1
JUL 11	17	63.3	2.7	63.0	67.4 73	57.4 62	78 73	68.4	4.1	69.0	47 72	57.1	4.2	58.0	JUL 11
JUL 21	17	64.3	2.4	64.0	67.4 80	59.3 62	78 76	69.5	3.6	69.0	50 72	58.1	4.4	59.0	JUL 21
AUG 1	17	63.0	2.9	63.0	66.4 79	55.1 62	72 72	67.9	2.7	68.0	49 62	57.1	3.9	58.0	AUG 1
AUG 11	19	61.8	3.4	62.0	66.2 81	55.4 68	71 72	66.3	2.8	67.0	43 78	55.3	6.6	56.0	AUG 11
AUG 21	19	59.2	3.8	59.0	64.7 67	52.1 62	75 69	64.5	4.7	65.0	47 77	52.5	3.8	52.0	AUG 21
SEP 1	19	57.3	3.1	57.0	63.0 67	50.7 62	68 78	63.3	3.4	64.0	41 62	48.8	4.3	49.0	SEP 1
SEP 11	18	52.4	3.9	52.0	60.9 81	44.3 78	65 81	59.6	3.2	60.0	37 71	43.0	4.4	42.0	SEP 11
SEP 21	19	50.6	4.9	51.0	57.8 67	40.9 62	64 66	56.5	4.1	56.0	35 68	43.7	6.4	44.0	SEP 21
OCT 1	19	47.2	4.1	48.0	54.7 63	41.4 69	60 79	53.6	3.7	53.0	32 70	39.8	5.8	40.0	OCT 1
OCT 11	19	42.9	4.3	43.0	48.4 73	31.4 69	54 79	49.8	3.5	50.0	25 69	35.9	4.9	36.0	OCT 11
OCT 21	19	38.5	3.4	38.0	44.0 77	31.2 70	53 77	46.0	3.8	46.0	12 71	30.4	6.0	31.0	OCT 21
NOV 1	19	34.6	3.7	34.0	42.3 80	26.9 71	47 80	40.9	3.9	40.0	15 78	26.7	6.0	26.0	NOV 1
NOV 11	19	30.9	4.6	31.0	37.6 67	23.1 78	45 81	39.0	4.3	38.0	2 77	20.7	7.2	23.0	NOV 11
NOV 21	19	24.2	3.4	23.0	28.9 74	14.9 79	40 74	33.6	3.9	34.0	0 79	13.2	6.6	14.0	NOV 21
DEC 1	18	22.5	7.0	24.5	33.3 75	5.6 72	41 75	32.8	5.9	33.5	-12 72	11.0	10.1	15.0	DEC 1
DEC 11	18	19.7	6.1	20.0	28.7 79	8.9 67	38 79	30.3	4.3	31.0	-7 72	7.6	7.7	9.0	DEC 11
DEC 21	18	18.1	4.4	17.0	26.1 72	10.0 78	36 72	30.6	2.7	30.0	-20 78	4.1	8.6	5.5	DEC 21
MONTH															MONTH
JAN	20	18.0	5.0	17.0	26.3 67	6.5 79	43 71	34.4	4.9	36.5	-19 79	-3.3	9.0	-1.0	JAN
FEB	20	25.5	2.8	25.5	29.2 70	20.5 64	41 80	37.6	3.1	38.0	-6 72	8.4	7.5	9.0	FEB
MAR	19	31.2	3.6	30.0	37.5 81	25.2 64	50 78	42.9	3.1	42.0	8 76	16.8	6.6	15.0	MAR
APR	18	39.8	3.2	39.5	45.1 77	33.6 75	57 77	49.9	4.7	49.5	18 75	27.3	3.6	28.0	APR
MAY	17	48.6	2.1	48.0	52.5 69	44.9 74	68 81	59.9	3.2	60.0	30 68	36.2	3.5	36.0	MAY
JUN	17	56.3	2.1	55.0	60.8 77	52.6 62 M	72 74	66.8	3.0	67.0	40 73	44.9	3.0	45.0	JUN
JUL	17	63.1	2.2	63.0	66.5 75	57.6 62	78 76	71.2	3.5	71.0	47 72	53.1	2.7	53.0	JUL
AUG	17	61.4	2.8	60.0	65.4 81 M	55.6 62	75 69	69.2	2.3	68.0	43 78	51.2	4.8	51.0	AUG
SEP	18	53.3	3.0	53.0	58.5 79	47.2 62	68 78	63.7	3.0	64.0	35 68	40.3	3.9	40.0	SEP
OCT	18	42.5	2.7	42.0	46.8 79	37.1 69	60 79	54.1	3.0	53.5	12 71	29.0	5.5	30.0	OCT
NOV	19	29.9	2.2	30.0	33.2 81	24.9 79	47 80	41.9	3.5	42.0	0 79	12.2	6.0	13.0	NOV
DEC	18	20.0	3.8	19.0	26.4 79	13.6 78	41 75	34.7	3.7	35.0	-20 78	0.8	8.7	3.0	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 102575 DIXIE

1952-1980

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	28	14.5	8.0	15.0	27.3 53	-7.8 74	38 53	27.0	8.4	28.5	-20 79	0.3	9.2	0.0	JAN 1
JAN 11	28	19.9	6.0	20.0	32.6 53	6.0 63	39 53	30.9	4.7	32.0	-18 63	4.8	8.4	4.5	JAN 11
JAN 21	28	17.1	6.4	17.5	28.5 53	3.0 57	37 71	29.5	4.8	30.0	-14 80	2.4	9.3	5.0	JAN 21
FEB 1	28	20.7	5.9	19.5	34.9 63	11.4 72	42 63	30.3	4.6	30.0	-10 56	9.0	9.8	10.5	FEB 1
FEB 11	28	22.7	4.5	21.5	31.3 58	13.9 56	39 61	32.1	4.2	32.0	-13 56	11.6	8.0	12.5	FEB 11
FEB 21	28	22.1	6.8	23.0	31.7 68	6.3 62	40 54	31.1	5.1	31.5	-13 62	13.1	9.2	14.5	FEB 21
MAR 1	28	22.0	4.6	21.5	32.3 68	12.9 71	40 68	31.9	4.1	31.5	-9 55	10.6	7.7	10.5	MAR 1
MAR 11	28	23.8	4.5	24.0	35.1 72	14.6 65	40 72	33.0	3.7	33.0	-2 65	12.1	6.5	12.0	MAR 11
MAR 21	28	27.9	5.4	29.0	38.7 78	16.6 75	45 78	36.6	3.8	36.0	-2 75	17.0	8.5	17.0	MAR 21
APR 1	28	31.2	3.9	31.0	40.3 60	20.0 75	47 77	38.9	4.2	39.0	8 75	22.7	5.4	24.0	APR 1
APR 11	28	32.6	3.6	32.0	40.4 62	24.9 70	48 62	40.6	3.5	41.0	15 72	23.7	4.8	23.5	APR 11
APR 21	28	35.8	3.5	35.0	44.4 77	29.5 70	53 77	42.4	4.5	43.0	21 72	27.9	3.9	28.0	APR 21
MAY 1	28	39.6	4.0	39.0	47.6 66	32.3 75	54 80	46.3	4.6	46.0	19 67	30.8	5.7	31.5	MAY 1
MAY 11	28	42.4	3.8	42.0	49.9 54	31.6 74	58 58	50.1	4.8	50.0	22 74	33.6	4.2	35.0	MAY 11
MAY 21	28	44.7	4.1	43.0	55.3 58	37.7 75	60 80	52.9	4.3	53.0	25 66	35.4	5.3	35.0	MAY 21
JUN 1	28	48.6	4.1	47.0	56.6 77	42.6 54	67 77	55.9	4.3	55.0	32 55	40.4	4.7	41.0	JUN 1
JUN 11	28	50.3	3.9	49.5	60.8 74	45.1 73	66 74	57.7	4.2	57.0	35 76	42.2	4.5	42.0	JUN 11
JUN 21	28	51.8	3.4	51.0	58.2 70	45.1 69	67 70	59.9	3.5	61.0	35 76	41.8	4.8	41.5	JUN 21
JUL 1	29	54.7	3.4	54.0	63.6 75	46.1 55	69 56	61.4	4.0	61.0	39 71	46.3	4.6	45.0	JUL 1
JUL 11	29	57.3	3.1	57.0	63.1 60	50.6 80	70 75	63.7	4.1	63.0	42 72	50.0	4.4	50.0	JUL 11
JUL 21	29	58.1	2.1	58.0	63.0 60	52.5 63	70 66	64.8	3.1	66.0	43 72	51.2	3.9	51.0	JUL 21
AUG 1	28	57.2	2.7	57.0	62.6 71	51.1 56	71 61	63.8	3.5	63.5	41 75	50.3	4.0	50.0	AUG 1
AUG 11	28	55.9	3.2	56.0	62.4 67	49.8 78	66 60	61.8	2.7	62.0	39 80	49.3	5.7	51.0	AUG 11
AUG 21	28	52.7	3.6	52.0	58.5 67	45.2 60	69 69	59.8	4.3	58.0	36 60	44.4	4.9	44.5	AUG 21
SEP 1	29	50.7	3.4	49.0	59.4 67	44.6 64	64 67	57.4	3.7	57.0	34 76	41.6	4.2	41.0	SEP 1
SEP 11	29	47.3	4.1	47.0	54.1 53	36.9 65	60 66	54.3	4.0	55.0	24 65	38.2	5.5	39.0	SEP 11
SEP 21	29	45.1	4.8	45.0	53.1 67	35.9 72	60 66	51.2	4.3	51.0	28 54	37.3	5.7	37.0	SEP 21
OCT 1	29	42.3	3.8	42.0	49.1 63	34.5 73	55 63	48.9	3.2	48.0	25 77	34.5	5.6	34.0	OCT 1
OCT 11	29	39.4	3.9	39.0	45.2 63	26.6 69	51 55	45.8	3.4	46.0	18 69	31.1	4.7	31.0	OCT 11
OCT 21	29	34.7	4.1	35.0	42.0 62	24.7 71	49 59	41.9	3.4	42.0	3 71	25.6	7.1	27.0	OCT 21
NOV 1	28	30.7	4.4	30.0	38.6 76	19.7 71	43 78	37.8	3.3	37.5	5 78	21.2	7.9	22.5	NOV 1
NOV 11	28	26.6	6.3	28.5	36.6 54	11.0 55	46 53	36.1	4.6	37.0	-16 55	14.8	10.6	15.5	NOV 11
NOV 21	28	22.5	4.5	23.5	31.4 53	10.9 79	40 54	32.1	5.2	33.5	-4 75	10.3	7.8	11.5	NOV 21
DEC 1	29	20.5	5.9	21.0	29.4 65	-0.4 72	38 65	31.1	3.8	31.0	-17 72	7.3	9.3	8.0	DEC 1
DEC 11	29	19.3	6.2	19.0	29.2 62	6.5 67	37 62	29.9	4.8	30.0	-22 64	6.1	10.7	8.0	DEC 11
DEC 21	29	18.7	5.0	18.0	33.0 80	6.1 78	39 55	29.9	4.2	29.0	-21 78	5.9	8.4	7.0	DEC 21
MONTH															MONTH
JAN	28	17.2	4.4	16.5	29.4 53	5.7 79	39 53	33.3	3.0	33.0	-20 79	-5.5	7.9	-1.0	JAN
FEB	28	21.8	3.9	21.0	30.7 63	14.8 55	42 63	34.4	3.6	34.5	-13 62	4.3	8.6	6.0	FEB
MAR	28	24.7	3.4	24.5	30.4 68	17.6 65	45 78	37.6	2.9	37.5	-9 55	7.4	6.1	8.0	MAR
APR	28	33.2	2.6	33.0	36.9 62	27.0 75	53 77	43.8	3.7	44.0	8 75	20.6	4.5	20.0	APR
MAY	28	42.3	2.9	41.0	49.7 58	37.0 75	60 80	54.1	3.6	54.5	19 67	28.6	4.7	29.0	MAY
JUN	28	50.2	2.3	49.0	55.7 61	46.6 75	67 77	61.6	3.3	62.0	32 55	38.0	3.5	37.0	JUN
JUL	29	56.8	1.7	56.0	61.5 75	54.0 63	70 75	66.7	2.6	67.0	39 71	45.3	3.8	44.0	JUL
AUG	28	55.2	2.5	54.5	60.4 61	51.1 80	71 61	64.9	3.1	65.0	36 60	43.8	4.2	44.5	AUG
SEP	29	47.7	3.1	47.0	53.1 67	41.3 65	64 67	57.8	3.6	58.0	24 65	34.4	4.0	35.0	SEP
OCT	29	38.7	2.4	38.0	42.9 52	33.0 69	55 63	49.3	2.7	49.0	3 71	24.0	6.0	25.0	OCT
NOV	28	26.6	3.4	25.5	33.5 54	21.7 55	46 53	38.8	3.4	38.5	-16 55	6.4	7.8	7.0	NOV
DEC	29	19.5	3.6	20.0	25.7 58	9.7 78	39 55	33.6	3.1	34.0	-22 64	-0.5	9.4	2.0	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 105708 MC CALL 1951-1980

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	30	18.9	6.5	19.0	28.2 53	3.4 74	40 53	29.5	6.3	30.5	-12 79	6.3	7.6	5.0	JAN 1
JAN 11	30	23.5	6.1	24.5	31.9 78	10.2 62	41 73	32.3	5.5	33.0	-4 63	10.8	7.8	11.0	JAN 11
JAN 21	30	20.6	5.9	20.0	29.0 53	6.3 57	39 76	31.9	5.0	32.0	-10 62	7.1	8.7	8.0	JAN 21
FEB 1	30	24.1	5.6	23.5	38.4 63	11.6 56	42 63	32.0	4.4	32.0	-9 56	13.6	9.2	13.5	FEB 1
FEB 11	30	25.3	5.3	24.0	33.5 63	15.1 52	41 72	34.3	3.8	35.0	-10 56	15.2	8.9	17.0	FEB 11
FEB 21	30	25.1	6.7	26.5	35.9 68	10.3 62	42 73	32.7	5.9	34.0	-4 62	16.4	8.5	17.0	FEB 21
MAR 1	30	25.7	5.1	25.0	34.4 75	15.3 51	46 72	34.4	5.3	35.0	-1 55	15.8	7.3	15.5	MAR 1
MAR 11	30	27.4	4.7	27.0	39.9 72	17.1 55	44 72	35.9	3.9	36.0	3 56	17.4	6.6	17.0	MAR 11
MAR 21	30	31.5	4.5	31.0	43.8 78	23.1 75	48 78	39.1	3.9	39.5	7 75	22.2	6.7	22.5	MAR 21
APR 1	30	35.1	3.8	35.0	41.4 60	24.8 75	49 77	41.3	3.9	41.0	15 75	27.5	4.9	28.0	APR 1
APR 11	30	36.8	3.7	36.0	45.6 62	27.8 55	51 62	43.0	4.0	43.0	22 72	29.8	4.6	29.0	APR 11
APR 21	30	40.0	4.7	39.0	52.4 77	32.2 55	57 77	46.0	5.0	45.5	22 55	32.5	5.3	32.0	APR 21
MAY 1	30	44.2	4.0	44.0	54.6 66	37.1 59	61 66	51.3	4.4	52.0	28 51	36.0	5.2	36.0	MAY 1
MAY 11	30	46.9	3.9	46.0	56.5 73	36.6 74	63 58	54.8	4.7	54.5	28 74	37.8	4.1	38.0	MAY 11
MAY 21	30	49.5	4.6	49.0	61.1 58	42.1 54	68 77	57.6	5.2	56.5	32 54	40.4	5.1	41.0	MAY 21
JUN 1	30	53.3	4.8	52.0	62.4 77	43.4 54	74 77	60.1	4.4	59.0	34 54	45.5	5.3	44.5	JUN 1
JUN 11	30	55.2	4.6	54.5	65.6 74	46.6 54	70 74	62.4	4.4	62.0	37 54	47.3	5.6	46.5	JUN 11
JUN 21	30	56.7	4.2	56.0	65.1 61	48.5 69	71 73	64.2	4.6	65.0	40 69	48.2	4.6	47.0	JUN 21
JUL 1	30	60.2	3.5	60.0	67.2 75	49.8 55	74 68	66.6	3.8	67.0	40 55	52.4	4.2	52.0	JUL 1
JUL 11	30	63.4	2.9	63.0	68.8 60	57.4 80	76 73	69.5	3.7	69.0	48 74	56.6	3.9	56.5	JUL 11
JUL 21	30	64.5	2.3	64.0	69.7 60	59.8 63	77 59	70.5	2.7	71.0	50 72	57.6	4.2	57.5	JUL 21
AUG 1	30	63.0	3.1	63.0	69.8 61	56.6 56	76 70	68.9	3.9	69.0	49 56	56.9	4.4	57.0	AUG 1
AUG 11	30	61.7	3.7	62.0	67.7 61	54.6 78	78 61	67.8	3.3	67.0	41 68	55.0	6.0	56.5	AUG 11
AUG 21	30	57.6	3.6	57.0	66.4 61	50.9 60	73 69	65.1	3.6	65.0	41 60	49.5	5.1	49.0	AUG 21
SEP 1	30	56.0	2.9	55.0	62.6 55	49.6 64	71 63	62.5	3.6	62.0	41 76	48.1	4.0	47.0	SEP 1
SEP 11	30	52.4	3.6	52.5	58.1 53	42.9 78	66 59	59.8	4.0	60.0	34 65	43.7	4.7	43.5	SEP 11
SEP 21	30	50.0	5.1	49.0	60.0 67	40.2 61	65 66	56.3	4.5	55.0	34 54	42.4	5.8	41.0	SEP 21
OCT 1	30	46.9	4.0	46.5	55.6 63	39.9 77	61 79	54.0	3.6	53.0	32 73	39.0	5.2	38.5	OCT 1
OCT 11	30	44.0	3.4	44.0	50.4 58	35.6 69	59 79	50.7	4.1	51.0	29 69	36.9	3.7	37.0	OCT 11
OCT 21	30	39.0	4.1	39.0	47.3 62	31.0 56	53 59	46.3	3.6	47.0	18 71	31.2	6.1	32.0	OCT 21
NOV 1	30	36.1	3.8	35.5	42.9 80	28.3 71	49 78	42.0	3.8	41.0	18 55	27.9	5.7	29.0	NOV 1
NOV 11	30	31.0	5.4	30.5	40.4 67	15.4 55	47 54	38.8	4.1	39.0	-5 55	21.9	8.2	21.5	NOV 11
NOV 21	30	27.8	3.8	27.5	34.6 53	16.4 52	46 66	36.0	4.8	36.5	7 79	18.3	5.5	19.0	NOV 21
DEC 1	30	25.3	5.0	26.0	33.9 75	10.3 72	40 75	33.8	3.4	34.0	-9 72	15.2	8.5	19.0	DEC 1
DEC 11	30	24.0	5.2	24.0	33.9 69	13.5 67	38 69	32.5	4.3	33.5	-9 64	13.5	8.1	14.0	DEC 11
DEC 21	30	22.4	4.6	22.0	34.6 80	11.4 78	43 64	32.4	4.0	32.0	-10 78	10.7	7.1	12.0	DEC 21
MONTH															MONTH
JAN	30	21.0	4.2	21.0	29.6 53	11.0 79	41 73	35.3	3.2	36.0	-12 79	1.2	7.2	0.5	JAN
FEB	30	24.8	4.3	24.0	35.3 63	16.8 56	42 73	36.2	3.3	36.0	-10 56	9.0	8.4	10.5	FEB
MAR	30	28.3	3.8	28.0	36.3 78	19.7 55	48 78	39.9	3.6	40.0	-1 55	13.3	6.3	15.0	MAR
APR	30	37.3	3.1	37.0	43.9 77	29.9 55	57 77	46.8	4.4	47.0	15 75	25.7	4.0	27.0	APR
MAY	30	46.9	2.9	46.0	53.4 58	40.5 55	68 77	58.7	4.7	58.5	28 74	33.6	3.9	33.0	MAY
JUN	30	55.0	2.8	54.5	62.1 61	49.7 54	74 77	66.5	3.2	66.0	34 54	42.8	3.6	43.0	JUN
JUL	30	62.8	1.7	62.0	67.6 60	59.9 63	77 59	72.1	2.4	72.0	40 55	51.5	3.7	51.0	JUL
AUG	30	60.7	2.7	59.5	67.9 61	56.2 75	78 61	70.3	3.2	70.5	41 68	48.9	5.2	49.0	AUG
SEP	30	52.8	2.9	52.0	58.7 63	48.2 71	71 63	63.2	3.3	63.0	34 65	40.0	4.1	41.0	SEP
OCT	30	43.1	2.2	42.0	47.7 65	39.6 69	61 79	54.5	3.3	53.5	18 71	30.2	4.9	30.5	OCT
NOV	30	31.7	3.0	31.0	36.4 54	25.1 55	49 78	42.8	3.6	42.5	-5 55	15.7	6.0	17.0	NOV
DEC	30	23.9	3.3	23.0	29.9 58	15.4 78	43 64	36.0	3.0	37.0	-10 78	6.6	7.5	9.0	DEC

(con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 105897 MIDDLE FORK LODGE — 1971-1981

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	10	17.0	9.5	20.0	30.3 81	1.4 79	44 78	26.8	9.8	28.0	-11 79	5.0	9.9	3.0	JAN 1
JAN 11	10	26.6	3.2	26.5	31.8 78	19.3 79	38 74	35.5	2.6	36.0	6 74	13.3	6.4	11.0	JAN 11
JAN 21	10	22.8	6.2	22.0	30.9 74	10.9 79	37 81	32.9	5.1	35.0	-2 79	11.8	9.5	16.0	JAN 21
FEB 1	9	24.4	4.8	25.0	33.1 78	17.6 76	39 78	34.1	4.0	34.0	-3 79	11.7	10.4	17.0	FEB 1
FEB 11	9	31.0	3.4	30.0	37.3 77	26.7 78	43 77	37.8	3.6	38.0	13 81	22.0	6.1	21.0	FEB 11
FEB 21	9	30.9	4.4	31.0	36.9 81	23.3 75	42 72	37.7	3.2	37.0	14 75	24.3	6.6	26.0	FEB 21
MAR 1	10	34.1	4.1	34.5	39.4 81	24.4 76	47 72	40.3	3.8	40.5	13 76	27.2	6.6	27.5	MAR 1
MAR 11	10	36.4	4.3	35.0	43.3 72	30.3 77	48 72	42.5	4.1	43.5	24 76	29.9	4.9	28.5	MAR 11
MAR 21	10	36.6	5.5	35.5	47.9 78	27.1 75	52 78	43.6	4.4	44.0	13 75	29.1	7.9	29.0	MAR 21
APR 1	10	39.4	3.8	39.0	43.9 77	31.3 75	55 77	46.2	5.4	45.0	24 75	32.7	3.9	33.0	APR 1
APR 11	11	42.2	3.5	42.0	48.1 80	34.4 72	57 81	49.3	4.4	49.0	28 72	33.9	2.9	34.0	APR 11
APR 21	11	46.8	5.1	46.0	55.3 80	39.4 75	58 81	51.9	5.0	52.0	33 72	39.6	4.9	38.0	APR 21
MAY 1	10	47.6	2.8	47.0	51.6 71	42.9 75	61 81	53.7	3.8	54.0	34 72	40.3	4.6	39.5	MAY 1
MAY 11	10	49.9	4.4	49.5	56.3 73	40.6 74	63 73	57.7	4.8	59.0	34 74	41.0	3.4	41.0	MAY 11
MAY 21	10	52.3	3.0	51.5	57.3 81	48.2 77	63 81	59.5	3.7	61.0	39 78	43.8	3.8	43.5	MAY 21
JUN 1	11	56.4	4.8	55.0	67.0 77	50.5 75	74 77	63.6	4.3	64.0	44 71	48.6	4.9	46.0	JUN 1
JUN 11	11	57.1	4.5	55.0	67.9 74	52.1 81	71 74	63.9	4.3	65.0	41 76	49.1	6.5	49.0	JUN 11
JUN 21	11	61.0	3.7	60.0	65.6 73	54.8 75	71 79	67.8	2.5	68.0	43 75	53.5	5.8	54.0	JUN 21
JUL 1	9	63.3	2.9	63.0	67.4 75	58.4 71	76 81	69.8	3.5	70.0	46 81	54.3	4.4	56.0	JUL 1
JUL 11	9	66.4	2.8	66.0	71.1 73	62.8 80	76 77	72.3	3.8	74.0	49 74	58.4	5.4	58.0	JUL 11
JUL 21	9	67.9	2.2	67.0	72.1 80 M	64.1 81 M	77 80	72.4	3.2	74.0	58 73	61.9	3.6	61.0	JUL 21
AUG 1	10	66.6	3.0	67.0	70.3 71	61.3 76 M	76 72	72.1	2.2	72.0	53 76	60.6	5.3	62.0	AUG 1
AUG 11	10	64.0	4.8	65.0	69.7 81 M	57.6 78	73 77	69.1	3.8	71.0	49 78	57.7	6.8	57.5	AUG 11
AUG 21	10	61.3	3.7	60.5	68.3 81 M	54.9 75	73 77	67.2	4.8	68.0	48 77	52.5	4.9	50.5	AUG 21
SEP 1	10	59.9	2.1	59.5	62.6 81	57.2 72	69 78	65.2	3.2	67.0	48 76	52.2	3.6	51.5	SEP 1
SEP 11	10	55.7	4.6	55.5	64.2 81 M	47.3 78	68 81	61.4	4.3	61.5	39 78	46.9	5.3	47.5	SEP 11
SEP 21	10	51.7	5.3	53.0	58.4 79	44.2 72	64 79	57.6	3.8	57.5	35 72	44.6	6.6	45.0	SEP 21
OCT 1	10	50.0	4.3	50.0	57.4 79	44.4 81 M	62 79	55.6	3.8	56.0	37 81	42.5	5.4	42.0	OCT 1
OCT 11	10	46.9	2.4	46.5	50.3 73	43.6 71	58 79	53.0	3.2	53.5	35 71	39.7	3.3	39.5	OCT 11
OCT 21	11	40.0	3.5	40.0	46.2 77	33.1 71	54 77	46.5	4.0	47.0	16 71	32.2	5.9	33.0	OCT 21
NOV 1	9	37.2	4.7	36.0	44.4 80	31.1 71	50 76	42.9	4.7	42.0	21 73	30.9	7.2	32.0	NOV 1
NOV 11	9	32.7	3.7	34.0	36.6 81	26.4 75 M	44 76	38.9	3.0	38.0	14 78	24.7	5.7	25.0	NOV 11
NOV 21	10	27.6	3.4	27.0	31.7 74	20.4 79	43 74	36.7	3.7	36.5	9 79	18.7	6.0	21.5	NOV 21
DEC 1	10	26.4	7.3	26.5	35.8 75	12.5 72	41 75	36.7	3.7	37.5	-5 72	14.6	10.6	18.0	DEC 1
DEC 11	9	24.2	5.5	25.0	30.8 73	14.0 72	36 79	32.9	3.5	34.0	-8 72	14.4	10.1	17.0	DEC 11
DEC 21	10	25.0	6.1	23.0	37.6 80 M	16.9 78	41 80	34.9	4.0	34.0	-9 78	14.3	10.8	14.0	DEC 21
MONTH															MONTH
JAN	10	22.2	5.0	22.0	29.0 81	10.6 79	44 78	36.8	3.4	37.0	-11 79	2.5	8.8	0.0	JAN
FEB	9	28.6	2.5	28.0	31.6 77	25.1 75	43 77	39.6	2.2	40.0	-3 79	10.4	9.3	13.0	FEB
MAR	10	35.7	3.4	35.0	40.4 78	29.8 76 M	52 78	44.8	3.4	45.0	13 76	23.4	6.5	24.5	MAR
APR	10	43.0	3.3	42.0	47.6 77	37.3 75	58 81	52.7	4.7	53.0	24 75	31.0	3.1	31.5	APR
MAY	10	50.0	1.9	49.5	52.6 76	47.[illegible] 74	63 81	61.2	2.0	62.0	34 74	38.0	3.1	37.5	MAY
JUN	11	58.2	3.0	57.0	64.6 77	53.6 75 M	74 77	68.5	3.2	69.0	41 76	45.8	4.8	45.0	JUN
JUL	9	65.9	1.2	65.0	68.0 75	64.6 71	77 80	74.8	1.8	75.0	46 81	53.2	4.1	56.0	JUL
AUG	10	63.9	3.1	63.0	68.5 81 M	59.3 75	76 72	72.3	2.1	72.5	48 77	52.3	4.9	50.0	AUG
SEP	10	55.8	2.8	56.0	60.1 79	51.1 71	69 78	65.7	2.6	67.0	35 72	43.2	5.9	43.0	SEP
OCT	10	45.4	2.1	45.0	49.1 79	41.7 71	62 79	56.1	3.1	56.0	16 71	31.8	6.0	33.0	OCT
NOV	8	32.7	2.3	31.5	35.5 76	28.7 79	50 76	43.9	4.3	42.5	9 79	17.0	5.3	17.5	NOV
DEC	9	24.7	4.3	25.0	29.6 75	18.1 78	41 80	37.3	3.6	39.0	-9 78	6.2	10.2	13.0	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 107706 RIGGINS 1951-1980

		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRO. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRO. BEGINS
JAN 1	29	32.6	6.7	33.0	44.3 54 M	14.6 74	55 53	40.3	7.3	41.0	2 79	24.0	8.1	26.0	JAN 1
JAN 11	29	36.2	5.4	37.0	46.8 53 M	21.0 63	53 53	42.0	5.3	42.0	5 63	28.1	8.1	30.0	JAN 11
JAN 21	28	34.7	6.3	35.5	46.1 53	18.1 57	54 53	42.3	5.6	42.0	5 62	24.8	9.3	28.5	JAN 21
FEB 1	28	38.9	5.1	39.0	48.1 63	27.8 76	57 63	45.6	5.2	44.0	13 56	31.3	8.5	33.5	FEB 1
FEB 11	28	40.6	4.1	40.0	48.3 77	31.1 56	56 70	47.4	3.9	47.0	12 56	33.2	6.8	34.0	FEB 11
FEB 21	26	41.9	5.6	42.0	48.5 73	22.7 60	56 73	48.1	5.1	47.0	11 60	35.5	7.9	37.5	FEB 21
MAR 1	26	42.1	3.9	42.0	49.3 68	32.9 76	61 72	48.6	5.2	48.0	27 51	35.1	4.2	34.5	MAR 1
MAR 11	27	44.4	3.6	43.0	55.5 72	39.8 65	61 72	51.2	4.2	51.0	24 65	36.9	4.6	37.0	MAR 11
MAR 21	28	47.9	4.7	48.0	59.1 78	36.6 75	65 78	54.9	5.0	56.0	29 75	39.6	4.6	40.0	MAR 21
APR 1	26	50.8	4.1	50.0	60.2 60 M	40.2 75	65 60	57.5	4.4	57.5	33 76	42.8	4.1	43.5	APR 1
APR 11	27	51.2	3.7	51.0	60.7 62 M	43.6 55 M	70 62	58.7	5.2	60.0	36 72	43.3	3.5	43.0	APR 11
APR 21	27	53.5	5.0	53.0	66.9 77	45.5 75	73 77	61.0	5.9	61.0	39 57	45.3	4.1	45.0	APR 21
MAY 1	30	57.3	4.4	57.0	69.3 66	49.1 75 M	77 66	64.9	5.4	65.0	41 79	48.6	5.6	48.0	MAY 1
MAY 11	30	60.0	4.1	59.5	69.3 73	50.6 74	77 54	68.9	4.7	69.0	44 71	50.3	3.7	50.0	MAY 11
MAY 21	30	61.7	4.7	61.5	73.8 58	54.2 53 M	79 66	70.2	4.7	71.0	45 80	52.9	5.6	53.0	MAY 21
JUN 1	30	65.3	4.7	64.5	73.7 69	57.2 54 M	81 77	72.5	4.8	73.0	48 55	57.2	5.4	56.5	JUN 1
JUN 11	30	67.2	4.4	65.5	79.3 74	61.3 52	82 74	74.3	4.0	74.0	49 76	58.7	6.0	58.5	JUN 11
JUN 21	30	69.5	4.3	68.5	77.9 73	61.4 75	88 70	77.3	5.2	77.0	51 75	60.6	5.0	59.5	JUN 21
JUL 1	30	73.1	3.9	73.0	80.4 68	61.7 55	88 73	80.6	4.2	81.0	56 55	64.6	4.1	65.0	JUL 1
JUL 11	30	76.6	3.2	76.0	84.1 60	71.1 80	89 60	83.0	3.2	83.0	62 71	68.8	4.5	68.0	JUL 11
JUL 21	30	78.3	2.6	78.0	82.8 51	73.0 54	89 59	83.9	3.1	84.0	63 65	70.6	4.3	71.0	JUL 21
AUG 1	30	77.5	3.6	77.5	86.0 71	69.8 56	92 61	83.4	3.9	83.0	64 75	70.8	4.7	70.5	AUG 1
AUG 11	30	76.0	4.6	76.0	84.9 67	65.4 78	88 61	81.6	3.8	82.0	52 68	68.9	6.9	70.0	AUG 11
AUG 21	30	71.8	4.6	70.0	80.6 61	63.6 60 M	90 69	79.6	5.3	79.5	55 54	63.2	5.5	62.5	AUG 21
SEP 1	30	70.2	3.7	69.0	79.9 67	63.3 64	86 67	77.2	4.0	77.0	55 64	61.2	4.3	60.0	SEP 1
SEP 11	30	65.6	4.5	65.0	74.1 53	54.4 78	81 53	73.4	4.7	74.0	43 65	57.1	5.2	57.0	SEP 11
SEP 21	30	63.1	6.1	63.0	74.6 67	54.6 58 M	81 52	69.5	5.9	69.0	46 54	55.4	6.5	55.0	SEP 21
OCT 1	30	59.3	4.3	58.5	67.8 65	51.5 73	78 63	66.7	4.8	67.0	40 75	51.2	5.5	50.5	OCT 1
OCT 11	30	55.1	4.0	55.5	63.9 63	44.8 69	70 53	61.6	4.7	62.0	40 69	47.9	3.6	48.0	OCT 11
OCT 21	30	50.6	4.2	51.0	57.5 52	42.5 56	65 54	57.3	4.9	58.0	25 71	43.5	5.8	43.0	OCT 21
NOV 1	27	46.3	3.7	46.0	53.4 65	40.4 73	59 65	53.2	3.2	53.0	29 78	39.6	5.2	41.0	NOV 1
NOV 11	25	42.2	5.6	43.0	49.2 65	23.9 55	58 66	50.4	4.2	51.0	7 55	33.9	8.0	35.0	NOV 11
NOV 21	27	39.1	4.0	39.0	45.7 53 M	30.6 75	54 66	46.1	5.1	48.0	19 77	31.7	5.6	32.0	NOV 21
DEC 1	27	37.1	5.1	38.0	43.5 65	19.1 72	52 68	44.8	4.4	46.0	5 72	29.3	7.5	32.0	DEC 1
DEC 11	27	36.2	4.9	37.0	43.7 73	24.6 67	50 73	43.0	3.7	43.0	3 64	27.8	9.1	30.0	DEC 11
DEC 21	27	35.8	4.5	36.0	45.5 80 M	25.4 78	52 55	43.6	4.6	44.0	4 78	26.7	7.9	28.0	DEC 21
MONTH															MONTH
JAN	28	34.6	4.6	34.0	45.2 53 M	22.0 79	55 53	45.2	4.4	46.0	2 79	18.5	8.8	19.0	JAN
FEB	25	40.8	3.5	41.0	46.6 63	33.0 56	57 63	50.7	4.3	52.0	11 60	28.9	8.1	32.0	FEB
MAR	26	44.8	3.1	44.0	50.8 78	38.6 76 M	65 78	55.4	4.7	56.0	24 65	33.2	3.8	34.0	MAR
APR	26	51.7	3.3	51.5	57.9 77	44.6 75	73 77	62.3	5.3	63.0	33 76	40.5	3.2	40.5	APR
MAY	30	59.8	3.0	59.5	67.6 58	54.6 59	79 66	72.1	3.8	72.0	41 79	46.3	3.5	46.0	MAY
JUN	30	67.3	2.9	67.0	73.4 61	62.3 53 M	88 70	79.2	4.0	80.0	48 55	54.1	3.9	53.0	JUN
JUL	30	76.1	2.0	75.0	81.0 60	71.5 55	89 60	85.5	2.2	86.0	56 55	63.9	3.7	63.5	JUL
AUG	30	75.0	3.3	74.5	82.4 61	69.6 75	92 61	84.8	3.5	85.0	52 68	62.3	5.3	62.5	AUG
SEP	30	66.4	3.6	66.0	74.5 67	59.8 70	86 67	77.7	3.8	78.0	43 65	52.9	5.0	52.5	SEP
OCT	30	55.0	3.1	54.0	61.9 79 M	49.3 75	78 63	67.2	4.2	67.0	25 71	42.7	5.1	43.0	OCT
NOV	23	42.9	2.8	43.0	47.9 65	36.6 78	59 65	54.0	2.7	54.0	7 55	30.4	5.2	32.0	NOV
DEC	27	36.3	3.2	36.0	41.5 58	27.4 78	52 68	47.4	2.9	47.0	3 64	21.7	8.9	24.0	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 108076 SALMON - SALMON 1 N 1951-1980

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	30	16.8	9.9	16.5	33.9 66	-7.3 74	47 53	29.8	9.5	30.5	-22 79	3.1	11.3	3.0	JAN 1
JAN 11	30	22.7	8.5	25.0	39.4 53	2.3 60	50 53	33.5	7.4	34.0	-11 63	9.2	10.8	10.0	JAN 11
JAN 21	30	19.8	9.3	20.0	36.8 53	0.1 79	47 53	32.4	7.8	31.0	-19 62	5.9	12.7	9.0	JAN 21
FEB 1	30	24.5	7.4	24.0	36.8 63	2.6 56	48 61	34.8	6.6	37.0	-19 56	13.5	11.8	15.5	FEB 1
FEB 11	30	28.9	5.8	28.5	37.4 70	17.1 56	48 70	38.3	5.1	39.0	-5 56	18.3	8.3	19.0	FEB 11
FEB 21	30	30.1	7.8	32.5	39.4 54	9.3 60	47 72	38.4	5.7	39.5	-6 60	22.5	10.6	25.0	FEB 21
MAR 1	30	31.6	5.6	32.5	41.0 68	17.4 52	49 80	40.3	5.7	41.5	-2 60	21.9	9.0	21.0	MAR 1
MAR 11	30	34.8	4.5	34.5	46.1 72	26.0 52	52 72	42.5	4.6	42.0	10 60	25.4	7.1	28.0	MAR 11
MAR 21	30	39.4	4.0	40.0	50.0 78	31.8 75	56 78	47.2	4.1	47.5	17 65	30.8	6.6	32.5	MAR 21
APR 1	30	43.0	3.2	42.0	50.2 69	36.1 75	60 77	50.5	4.2	50.5	26 75	35.3	4.0	35.0	APR 1
APR 11	30	44.9	3.6	44.0	52.2 62	36.6 70	62 62	52.4	3.9	53.0	25 66	36.9	4.9	37.0	APR 11
APR 21	30	47.6	4.3	46.0	58.3 77	40.6 70	63 77	54.9	4.9	56.0	34 67	39.3	4.3	37.0	APR 21
MAY 1	30	51.7	4.1	51.5	58.8 66	42.9 65	65 66	58.2	3.9	59.0	34 64	43.5	5.5	43.0	MAY 1
MAY 11	30	53.9	3.6	53.0	61.7 73	44.6 74	70 73	61.7	4.5	62.0	38 55	45.0	4.2	45.0	MAY 11
MAY 21	30	55.9	3.7	55.0	63.9 58	50.3 54	70 69	63.2	3.7	63.0	39 53	47.8	4.7	47.0	MAY 21
JUN 1	30	59.4	4.4	59.0	68.4 77	50.5 51	77 77	66.3	4.4	66.5	41 54	51.8	5.5	52.0	JUN 1
JUN 11	30	61.4	3.8	61.0	73.8 74	55.4 54	78 74	67.6	3.7	68.0	47 73	53.9	4.4	54.0	JUN 11
JUN 21	30	63.1	4.0	62.0	70.8 74	54.9 63	77 74	70.4	3.8	71.0	47 55	54.8	5.0	54.0	JUN 21
JUL 1	30	66.3	3.9	66.0	74.2 75	55.9 55	79 73	71.8	3.5	72.0	48 55	59.2	4.2	60.0	JUL 1
JUL 11	30	69.6	2.6	70.0	74.1 73	64.4 62	81 51	74.7	3.3	75.0	54 72	63.1	3.5	63.5	JUL 11
JUL 21	30	70.4	1.9	70.0	74.0 80	65.9 54	83 78	75.2	2.9	75.0	57 54	64.3	3.5	64.0	JUL 21
AUG 1	30	68.8	2.7	68.0	73.4 71	61.9 56	78 73	73.6	2.7	74.5	55 56	62.9	3.7	63.5	AUG 1
AUG 11	30	67.3	3.2	67.0	71.9 73	59.8 68	77 73	71.9	2.6	72.0	50 78	61.1	5.8	63.0	AUG 11
AUG 21	30	63.3	3.7	62.0	71.1 69	55.9 60	80 69	69.3	3.6	69.0	47 60	55.8	4.7	56.5	AUG 21
SEP 1	30	61.2	3.1	60.0	67.1 79	55.1 65	74 79	67.1	3.5	67.0	48 62	53.8	3.6	53.0	SEP 1
SEP 11	30	56.4	3.8	56.0	61.9 53	45.7 65	70 66	63.2	3.2	63.0	32 65	48.3	5.9	48.5	SEP 11
SEP 21	30	53.7	4.6	54.0	61.6 67	44.5 61	68 67	59.3	4.6	59.5	37 72	47.1	5.2	47.0	SEP 21
OCT 1	30	50.2	3.5	50.0	57.9 63	41.8 59	65 63	56.6	3.9	56.5	35 66	42.8	4.7	43.0	OCT 1
OCT 11	30	46.3	3.6	46.0	52.1 73	34.9 69	60 75	53.5	4.2	54.0	27 69	38.9	4.5	39.0	OCT 11
OCT 21	30	40.9	2.9	41.0	46.5 77	34.6 70	60 77	49.6	4.0	50.0	16 71	33.2	4.8	34.0	OCT 21
NOV 1	30	36.4	3.5	36.0	44.1 80	30.3 52	50 78	43.2	4.2	43.0	15 55	28.5	5.3	29.5	NOV 1
NOV 11	30	32.7	5.6	34.0	44.9 54	19.8 55	50 54	41.7	4.2	41.5	0 55	22.4	8.4	24.0	NOV 11
NOV 21	30	28.6	5.2	29.0	36.1 53	13.4 52	46 74	38.4	5.5	40.0	3 79	17.8	7.2	18.5	NOV 21
DEC 1	30	25.8	5.8	27.0	34.1 79	7.0 72	43 80	36.5	4.0	36.5	-10 72	14.5	9.8	16.0	DEC 1
DEC 11	30	23.3	6.3	24.5	33.3 62	11.9 67	41 57	33.2	4.6	33.0	-12 64	12.4	9.9	15.0	DEC 11
DEC 21	30	22.0	5.6	20.5	35.7 80	12.8 78	47 55	33.9	5.3	33.0	-16 78	9.6	9.2	12.0	DEC 21
MONTH															MONTH
JAN	30	19.8	6.7	19.0	34.3 53	2.8 79	50 53	37.3	5.6	38.5	-22 79	-2.7	10.3	-1.0	JAN
FEB	30	27.7	5.1	28.0	35.7 63	16.5 56	48 70	41.4	3.8	41.5	-19 56	10.1	11.4	13.0	FEB
MAR	30	35.4	3.7	35.5	42.1 68	25.9 52	56 78	48.1	3.6	48.5	-2 60	19.9	7.7	20.0	MAR
APR	30	45.2	2.6	44.5	49.8 77	40.3 70	63 77	56.4	3.5	56.0	25 66	33.5	3.5	33.5	APR
MAY	30	53.9	2.5	53.0	59.7 58	49.5 53	70 73	65.0	3.1	65.0	34 64	41.2	3.8	41.0	MAY
JUN	30	61.3	2.6	60.5	67.3 74	56.3 54	78 74	71.5	3.0	71.0	41 54	49.4	3.7	49.5	JUN
JUL	30	68.8	1.8	68.0	72.[illegible] 75	66.0 62	83 78	76.5	2.6	76.0	48 55	58.2	3.6	59.0	JUL
AUG	30	66.4	2.4	66.0	70.7 71	62.7 60	80 69	74.4	2.3	75.0	47 60	55.2	4.6	55.0	AUG
SEP	30	57.1	2.9	57.0	63.1 79	49.9 65	74 79	67.4	3.3	67.0	32 65	44.8	4.8	46.0	SEP
OCT	30	45.6	2.1	45.0	50.1 63	40.2 69	65 63	57.8	2.9	58.0	16 71	32.5	4.6	33.0	OCT
NOV	30	32.6	3.0	32.0	38.2 54	26.5 52	50 78	45.0	3.4	45.5	0 55	15.2	6.6	16.5	NOV
DEC	30	23.6	4.2	23.0	30.9 79	14.3 78	47 55	38.6	3.4	39.0	-16 78	4.8	9.0	7.0	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 108395 SHOUP 1966-1981

		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	16	18.9	9.9	21.0	31.9 66	-0.4 79	38 69	28.7	8.7	31.0	-14 79	7.4	11.1	7.5	JAN 1
JAN 11	16	27.4	3.8	27.0	34.3 67	17.9 79	40 67	34.9	3.2	35.5	4 77	15.3	8.0	15.0	JAN 11
JAN 21	16	24.1	7.8	23.5	34.3 71	6.6 79	42 71	33.4	6.4	35.5	-7 79	13.0	9.8	14.5	JAN 21
FEB 1	16	26.8	5.3	27.0	34.6 78	17.3 76	40 78	35.5	3.1	36.0	-1 79	16.9	9.1	20.0	FEB 1
FEB 11	16	31.6	3.2	30.0	37.7 70	27.2 69	45 70	38.9	3.0	38.0	15 72	23.3	5.3	21.0	FEB 11
FEB 21	16	34.0	3.4	34.0	39.4 68	27.4 75	46 68	40.1	2.6	39.5	19 75	28.3	5.7	28.0	FEB 21
MAR 1	16	35.4	4.5	35.0	42.7 68	26.4 76	51 80	42.3	4.3	43.0	16 76	28.1	7.5	29.5	MAR 1
MAR 11	16	38.7	2.5	38.0	43.6 72	34.0 69	51 72	44.4	2.9	43.5	22 69	31.8	4.4	31.5	MAR 11
MAR 21	16	41.5	3.8	40.0	50.5 78 M	33.7 75	57 66	47.5	4.2	46.5	22 75	34.2	5.4	34.5	MAR 21
APR 1	16	44.6	3.5	44.0	50.4 66	37.9 75	61 77	50.1	4.8	50.0	27 75	37.5	4.6	38.0	APR 1
APR 11	16	45.8	3.3	45.0	53.0 80	39.5 70	60 81	52.4	4.6	52.0	31 66	38.0	3.9	37.5	APR 11
APR 21	16	49.5	4.5	48.5	58.1 77	43.1 75	66 77	55.8	5.3	56.0	36 67	42.6	4.5	42.0	APR 21
MAY 1	16	53.2	3.7	51.5	61.6 66	47.6 75	66 66	58.8	3.4	59.0	37 68	45.8	5.2	44.5	MAY 1
MAY 11	16	54.3	3.8	54.0	60.9 73	44.9 74	67 73	61.1	4.4	61.5	41 74	46.4	3.8	46.5	MAY 11
MAY 21	16	57.0	3.0	56.5	62.2 66	52.5 77	69 66	64.0	2.6	64.0	45 77	49.3	2.9	49.0	MAY 21
JUN 1	16	60.6	3.6	59.5	68.6 77	56.6 80	77 77	67.1	4.0	66.0	45 73	53.4	4.3	52.0	JUN 1
JUN 11	16	61.6	3.6	62.0	70.8 74	55.4 81	74 74	67.6	3.5	68.0	48 81	53.6	3.9	53.0	JUN 11
JUN 21	16	64.8	4.0	64.0	70.3 73	56.7 69	76 70	71.3	3.0	71.0	51 78	57.0	4.6	56.0	JUN 21
JUL 1	15	67.9	3.3	69.0	72.6 75	63.3 77	76 73	72.6	2.5	73.0	54 77	60.9	4.1	61.0	JUL 1
JUL 11	15	70.6	2.1	70.0	74.6 66	66.9 80	78 79	75.3	2.3	75.0	56 72	64.9	4.1	65.0	JUL 11
JUL 21	15	71.7	1.7	72.0	74.0 66	68.4 70	82 66	76.5	2.3	76.0	59 72	66.3	3.9	67.0	JUL 21
AUG 1	16	70.7	2.3	71.0	73.1 79	65.9 76	78 73	74.8	1.7	74.5	57 74	65.3	4.0	66.0	AUG 1
AUG 11	16	68.3	4.1	69.0	73.8 67	61.3 68	76 69	72.4	2.6	73.5	51 78	61.8	7.0	63.5	AUG 11
AUG 21	16	66.1	3.7	65.5	71.5 67	61.1 77	79 69	70.6	3.8	71.0	52 77	59.9	4.4	60.0	AUG 21
SEP 1	16	63.6	3.0	62.5	69.8 67	60.1 72	74 67	68.7	2.8	69.0	51 76	57.0	3.5	56.0	SEP 1
SEP 11	16	58.2	3.7	58.0	67.4 81	51.5 78	69 81	64.2	3.0	64.5	43 70	50.4	4.7	50.0	SEP 11
SEP 21	16	55.1	4.8	54.5	63.9 67	47.0 72	68 66	59.6	4.5	58.0	41 72	49.0	6.3	47.5	SEP 21
OCT 1	16	50.5	2.9	50.0	56.4 79	46.7 73	61 75	56.1	3.1	56.0	38 68	43.5	3.9	42.5	OCT 1
OCT 11	16	46.7	3.6	46.0	51.4 78	37.6 69	59 79	52.9	4.0	52.5	31 69	41.4	4.2	41.0	OCT 11
OCT 21	16	41.8	2.8	41.5	46.3 77	36.9 70 M	55 77	49.0	2.8	49.0	18 71	34.4	5.5	35.5	OCT 21
NOV 1	16	38.0	2.3	37.0	42.1 76	33.0 71	50 78	44.2	2.9	44.5	23 78	31.4	4.5	32.5	NOV 1
NOV 11	16	34.5	3.9	35.0	40.1 67	27.6 78	48 74	41.7	3.8	41.5	11 77	26.4	5.7	26.5	NOV 11
NOV 21	16	29.3	3.6	29.0	34.2 66	21.9 79	43 74	37.3	3.9	37.5	8 75	19.8	6.7	20.5	NOV 21
DEC 1	16	27.0	5.8	28.5	34.4 79	10.7 72	42 79	35.2	3.4	35.5	-5 72	16.8	9.2	20.5	DEC 1
DEC 11	16	25.0	5.7	26.5	32.2 69	14.8 67	37 69	32.2	3.5	33.5	0 72	16.1	8.1	17.5	DEC 11
DEC 21	16	24.4	5.2	22.5	34.0 80	15.2 78	36 80	33.6	2.1	34.0	-13 78	13.1	10.0	14.0	DEC 21
MONTH															MONTH
JAN	16	23.5	5.5	23.5	31.7 67	8.0 79	42 71	37.1	3.2	37.5	-14 79	4.3	9.6	0.0	JAN
FEB	16	30.6	2.8	31.0	35.2 70	26.1 75	46 68	41.1	2.5	41.5	-1 79	15.8	8.2	19.0	FEB
MAR	16	38.6	2.4	38.0	42.9 68	34.2 76	57 66	48.2	4.0	48.0	16 76	26.2	6.2	25.5	MAR
APR	16	46.6	2.5	46.0	50.4 77	41.6 75	66 77	56.2	4.7	56.0	27 75	35.2	3.3	36.0	APR
MAY	16	54.9	2.2	54.5	58.8 66	52.1 75	69 66	64.9	2.1	64.5	37 68	43.3	3.4	43.0	MAY
JUN	16	62.3	2.2	62.0	66.9 77	58.8 75	77 77	72.0	3.0	71.5	45 73	51.4	3.2	52.0	JUN
JUL	15	70.1	1.6	70.0	72.5 66	67.4 72	82 66	77.3	1.8	77.0	54 77	60.1	3.6	61.0	JUL
AUG	16	68.3	2.8	68.5	72.1 67	64.7 76	79 69	75.3	1.9	75.0	51 78	58.3	5.5	60.0	AUG
SEP	16	58.9	3.0	58.0	64.1 67	54.4 70	74 67	68.8	2.7	69.0	41 72	46.8	4.0	46.5	SEP
OCT	16	46.2	1.7	46.0	49.5 79	42.5 69	61 75	56.6	2.5	56.0	18 71	33.8	5.3	34.5	OCT
NOV	16	33.9	1.9	34.0	36.8 66	30.0 79	50 78	45.1	2.6	45.0	8 75	18.9	5.9	19.5	NOV
DEC	16	25.4	3.9	26.0	31.9 79	17.5 78	42 79	36.1	2.5	36.0	-13 78	9.2	9.1	11.0	DEC

(con.)

Table 23 (Con.)

MEAN DAILY TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 109560 WARREN 1960-1981

		10-DAY AND MONTHLY PERIOD MEANS					10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JAN 1	22	15.8	7.1	15.5	24.8 69	-3.6 74	36 69	28.5	6.7	30.0	-19 79	1.6	9.0	2.5	JAN 1
JAN 11	22	21.5	6.6	23.0	28.6 70	5.9 63	39 73	31.6	5.8	33.0	-14 63	6.7	7.1	7.5	JAN 11
JAN 21	22	19.2	5.6	18.5	28.4 81 M	7.8 79	40 81	31.0	4.6	32.0	-9 62	5.5	8.0	7.0	JAN 21
FEB 1	22	23.5	5.0	22.5	34.7 63	15.3 76	43 63	32.9	4.3	33.0	-5 76	12.1	8.5	12.0	FEB 1
FEB 11	22	25.1	4.4	24.5	33.1 77	15.9 66	40 70	33.7	3.4	35.0	-3 65	14.3	7.4	16.0	FEB 11
FEB 21	22	23.5	7.0	25.0	32.3 68	4.9 62	40 73	31.5	5.6	32.0	-16 62	14.4	10.3	16.0	FEB 21
MAR 1	22	23.9	4.8	23.0	31.1 75	16.6 76	40 79	33.1	4.5	34.0	[illegible] 76	13.0	7.8	13.0	MAR 1
MAR 11	21	25.8	5.4	25.0	36.3 72	13.1 65	42 61	35.0	4.6	36.0	-4 65	14.5	7.6	14.0	MAR 11
MAR 21	22	28.9	4.9	29.0	39.8 78	19.3 75	44 78	37.0	3.6	37.5	-2 65	18.5	8.3	18.0	MAR 21
APR 1	22	31.8	4.0	31.0	40.1 60	22.0 75	46 77	38.7	4.2	38.5	10 75	23.4	4.4	23.0	APR 1
APR 11	22	32.7	4.1	32.0	41.0 62	24.9 70	47 81	40.8	4.2	41.0	13 66	23.0	5.3	22.5	APR 11
APR 21	22	36.5	4.3	35.0	46.4 77	29.5 67	53 77	42.9	4.9	43.0	23 72	29.0	4.7	28.0	APR 21
MAY 1	21	40.0	3.9	39.0	46.5 66	31.7 65	53 81	46.4	4.0	46.0	22 67	32.3	6.1	32.0	MAY 1
MAY 11	22	42.2	3.7	42.0	48.9 73	33.2 74	55 73	48.5	3.9	48.5	27 74	34.4	4.5	34.5	MAY 11
MAY 21	21	44.8	3.1	45.0	49.7 61	39.8 60	59 72	52.1	3.5	52.0	26 60	37.5	4.8	38.0	MAY 21
JUN 1	21	48.4	4.1	47.0	57.4 77	42.9 62	67 77	54.2	4.7	54.0	32 66	41.7	5.4	42.0	JUN 1
JUN 11	22	50.3	3.9	50.0	60.4 74	44.2 64	65 60	57.3	3.4	57.5	33 76	42.9	5.1	42.5	JUN 11
JUN 21	22	52.0	4.1	51.0	59.1 73	44.3 69	66 70	58.4	3.4	59.0	37 63	44.0	5.0	42.5	JUN 21
JUL 1	22	55.3	3.1	55.0	62.7 75	50.9 62	67 81	60.7	3.0	60.5	42 66	48.5	3.5	48.0	JUL 1
JUL 11	22	56.5	2.9	57.0	62.5 75	50.7 62	67 75	61.7	3.0	62.0	44 63	50.7	3.7	50.5	JUL 11
JUL 21	22	57.8	2.3	57.0	62.1 60	52.5 63	68 80	63.2	3.1	63.5	41 72	51.6	3.7	52.0	JUL 21
AUG 1	22	57.0	2.0	57.0	61.6 71	53.4 76	70 70	62.3	2.7	62.0	46 76	51.5	3.3	51.5	AUG 1
AUG 11	22	55.4	3.5	56.0	60.3 61	48.9 78	71 61	60.5	3.6	60.0	38 68	49.5	5.5	50.5	AUG 11
AUG 21	22	52.2	3.8	52.0	57.6 61	46.2 60	67 69	58.0	3.6	57.5	37 60	45.3	4.5	45.5	AUG 21
SEP 1	22	50.8	3.4	51.0	56.1 63	42.8 64	64 67	56.6	4.1	57.0	36 64	43.2	4.1	43.5	SEP 1
SEP 11	22	46.9	4.6	47.0	55.4 81	35.0 65	60 81	53.3	4.4	54.0	20 65	38.9	6.0	40.0	SEP 11
SEP 21	22	45.9	4.8	47.0	54.6 67	35.8 61	60 67	51.6	4.3	50.5	31 81	38.5	5.7	37.5	SEP 21
OCT 1	22	43.1	3.7	42.5	49.6 80	37.8 77	56 79	49.8	3.3	49.5	27 68	35.4	5.6	35.5	OCT 1
OCT 11	22	39.6	3.9	39.0	45.1 63	28.8 69	51 71	46.4	2.9	46.0	19 69	32.5	5.3	33.5	OCT 11
OCT 21	22	35.6	3.9	36.0	42.6 62	27.5 70	46 62	41.8	2.6	42.0	10 71	27.2	6.5	29.0	OCT 21
NOV 1	22	32.5	4.2	31.0	41.0 76	26.2 77	45 80	39.5	3.4	41.0	7 78	23.0	7.7	23.5	NOV 1
NOV 11	22	28.3	4.8	29.0	36.3 67	18.5 64	42 67	36.1	3.4	37.0	1 77	17.5	7.2	19.0	NOV 11
NOV 21	22	23.8	2.9	24.0	27.9 71	16.6 79	39 60	33.6	3.3	33.5	0 79	12.5	6.6	14.5	NOV 21
DEC 1	22	22.2	6.5	22.5	32.0 75	3.6 72	38 75	32.9	3.7	34.0	-13 78	9.2	10.7	12.5	DEC 1
DEC 11	22	20.5	6.5	20.0	30.9 69	5.6 67	37 72	30.9	4.9	31.5	-23 64	6.0	10.9	6.0	DEC 11
DEC 21	22	19.8	5.2	19.5	32.5 80	6.7 78	38 80	30.5	3.6	30.0	-22 78	6.5	9.7	8.5	DEC 21
MONTH															MONTH
JAN	22	18.8	3.6	18.0	25.1 81 M	9.8 79	40 81	34.9	3.1	35.0	-19 79	-2.7	7.8	-1.0	JAN
FEB	22	24.1	3.5	24.0	30.7 63	18.2 64	43 63	35.7	3.4	35.5	-16 62	6.4	8.8	9.0	FEB
MAR	21	26.5	3.7	26.0	32.5 78	17.4 65	44 78	38.6	2.9	39.0	-4 65	9.7	7.0	9.0	MAR
APR	22	33.7	2.9	33.0	38.7 77	28.3 75	53 77	44.0	4.0	43.5	10 75	20.3	4.1	20.0	APR
MAY	21	42.3	2.1	42.0	45.9 69	38.1 65	59 72	52.7	3.2	53.0	22 67	29.5	[illegible]	30.0	MAY
JUN	21	50.3	2.5	49.0	55.7 61	46.8 75	67 77	60.5	3.2	61.0	32 66	38.8	4.2	39.0	JUN
JUL	22	56.6	2.0	56.0	61.8 75	53.3 62	68 80	64.4	2.3	65.0	41 72	47.1	3.2	46.5	JUL
AUG	22	54.8	2.5	55.0	59.0 61	51.0 64	71 61	63.4	3.0	63.0	37 60	44.3	4.4	44.5	AUG
SEP	22	47.9	3.4	48.0	52.6 67	39.8 65	64 67	57.0	4.0	58.0	20 65	35.8	5.3	37.0	SEP
OCT	22	39.3	1.9	39.0	43.0 63	35.1 69	56 79	50.2	2.6	49.5	10 71	25.3	5.4	26.5	OCT
NOV	22	28.2	2.4	28.0	32.6 76	24.4 77	45 80	40.1	2.8	41.0	0 79	10.7	6.0	12.5	NOV
DEC	22	20.8	3.7	20.0	26.4 80	11.4 78	38 80	34.7	2.9	35.0	-23 64	-0.4	10.2	2.5	DEC

Table 24—Monthly and annual mean temperatures, °F, by individual years, at long-term stations adjacent to RNR. Means are arithmetic averages of daily maximum and minimum values; based on 24-hour periods ending at indicated observation times (m.s.t.). E denotes mean is different from originally published value; includes estimates for missing days and corrections for apparent errors. Values in parentheses are completely estimated. X denotes 6 or more days missing; mean as published

McCall, ID - Observation time mostly 1600 to 1700; 0900 during October 1934 to November 1948.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Mean temperature												
	°F												
1921	19.6	22.4	30.8	36.2	48.6	57.4	62.2	60.0	46.2	(45.3)	34.0	23.4	40.5
1922	12.2	19.9	24.2	31.8	45.0	58.4	63.2	63.0	53.6	44.0	29.1	19.0X	38.6
1923	21.0	19.3	22.6	37.0	46.8	52.2	65.2	59.4	54.6	40.4	33.0X	19.6X	39.3
1924	15.9	28.9X	25.0	36.6	49.5X	53.0X	62.1X	60.0X	52.7X	40.4X	22.4X	13.8X	38.4
1925	20.8X	24.3	29.4	43.0	53.2	58.4	65.4X	(60.0)	54.6X	(43.0)	32.0X	26.2X	42.6
1926	17.8X	28.5X	33.2X	43.0X	49.0X	55.2	65.0E	61.9E	(48.0)	46.1	36.2	24.7X	42.4
1927	21.2	22.4	26.8	34.8	43.6	54.6	61.5	59.4	50.4	46.5	33.7	18.2	39.4
1928	23.4	21.4	32.8	36.1	53.6	54.3	61.4	61.2	55.0	45.0	33.4	20.4	41.5
1929	9.8	14.2	28.3	31.8	43.2	51.8	62.2	64.4	49.4	43.9	28.6	28.9	38.0
1930	8.6	30.4	30.6	43.8	47.8	53.3	64.8	62.2	52.3	39.7	28.6	14.8	39.7
1931	18.9	20.0	28.6	38.0	48.5	55.0	64.8	62.8	50.4	42.3	27.6	18.6	39.6
1932	12.8	18.0	26.8	36.0	46.1	55.5	60.6	58.2	52.5	41.6	31.9	14.1	37.8
1933	19.4	11.3	27.4	35.2	42.6	58.2	64.2	60.7	50.8	46.4	33.9	29.4	40.0
1934	27.5	33.2	38.2	46.8	54.2	53.6	63.0	63.4	50.0	43.7	36.2	24.0	44.5
1935	22.8	21.9	23.6	35.6	44.8	(54.0)	61.4	59.4	54.8	40.2	23.6	18.6	38.4
1936	17.8	15.4	24.3	38.1	51.2	57.2	65.8	62.7	51.8	45.7	31.2	21.9	40.2
1937	5.5	17.2	32.5	34.6	49.2	54.2	64.7	59.2	54.4	44.8	34.4	27.2	39.8
1938	22.2	26.2	28.9	37.6	46.2	57.6	63.0	60.0	57.2	43.8	23.2	21.8	40.6
1939	19.0	16.4	29.4	40.6	50.2	51.8	62.9	63.0	52.7	42.6	34.9	31.4	41.2
1940	23.4	24.7	33.0	40.0	50.7	59.2	63.4	63.4	54.7	43.8	24.2	25.0	42.1
1941	21.0	24.8	33.4	(40.0)	47.9	54.4	64.2	59.6	47.6	42.2	34.0	25.2	41.2
1942	16.2	18.0	26.2	40.2	44.2	50.4	62.0	59.4	51.8	43.0	28.4	22.8	38.6
1943	15.4	22.2	23.9	42.0	43.6	50.4	62.0	60.0	55.0	43.0	32.0	22.8	39.4
1944	15.7	22.4	25.0	37.2	48.5	51.2	59.6	57.9	51.8	48.4	28.8	21.7	39.0
1945	22.2	25.8	27.3	33.2	46.0	50.5	62.0	59.8	47.7	44.6	27.4	18.4	38.7
1946	16.7	20.4	30.6	39.5	47.4	53.6	63.1	61.2	49.4	35.4	29.1	25.6	39.3
1947	16.4	27.8	33.0	39.0	51.8	50.1	62.8	59.4	51.8	45.4	26.4	21.0	40.4
1948	18.2	21.4	22.2	32.0	43.4	56.6	59.4	58.0	51.6	45.0	27.2	12.9	37.3
1949	2.9	18.8	33.8	42.6	52.2	53.2	61.5	61.9	56.3	38.5	35.5	22.3	40.0
1950	14.2	24.4	24.3	32.3	42.2	54.9	62.5	61.6	52.3	43.4	32.9	29.3	39.5
1951	20.2	22.8	22.3	35.6	47.8	52.0	64.0	60.0	53.3	40.2	30.5	19.8	39.0
1952	17.0	17.3	22.6	(38.5)	46.9	54.1	61.3	60.7	55.5	46.3	26.8	23.3	39.2
1953	29.6	23.2	27.5	32.4	42.7	50.6	62.6	60.0	55.0	46.3	35.7	23.1	40.7
1954	24.5	26.0	24.5	35.4	46.7	49.7	62.6	56.8	51.9	42.5	36.4	20.8	39.8
1955	17.3	17.0	19.8	30.0	40.6	54.1	60.1	61.7	52.4	41.9	25.1	22.7	36.9
1956	21.3	16.8	25.4	36.6	47.8	53.0	63.8	58.4	52.8	41.2	27.4	23.7	39.0
1957	11.6	23.6	29.5	36.9	46.7	54.5	61.8	59.6	55.9	40.8	28.0	25.1	39.5
1958	22.4	31.0	28.0	35.8	53.5	57.5	63.1	63.4	51.4	45.2	32.3	29.9	42.8
1959	25.6	24.4	27.8	38.4	(43.0)	57.9	63.9	60.0	49.7	44.0	31.3	24.5	40.9
1960	17.9	20.6	29.6	37.9	45.6	57.3	67.6	59.0	55.3	42.1	31.1	21.4	40.5
1961	22.3	30.8	31.0	37.2	47.3	62.1	65.8	67.9	49.0	41.5	27.6	19.4	41.8
1962	14.8	23.5	26.7	41.3	46.3	56.8	61.8	59.8	54.7	45.2	35.4	28.5	41.2
1963	18.2	35.3	31.6	36.9	50.3	55.0	59.9E	62.6E	58.7E	47.5	32.2	23.1	42.6
1964	19.8	19.0	24.2	36.2	46.0	53.9	64.2	59.2	50.4	46.2	30.9	24.7	39.6
1965	25.1	24.9	26.7	40.4	45.2	55.1	63.2	61.4	48.6	47.7	35.2	24.3	41.5
1966	22.1	23.1	28.9	39.2	51.7	54.5	61.9	61.1	58.3	43.1	35.2	25.7	42.1
1967	26.3	24.1	28.9	34.2	46.4	55.0	64.3	64.0	57.9	43.0	35.0	22.3	41.8
1968	21.1	29.8	34.7	36.2	45.5	55.2	63.9	57.7	52.2	41.9	31.2	23.1	41.0
1969	22.7	23.3	27.7	41.0	51.1	56.6	60.5	61.7	54.2	39.7	33.8	28.5	41.7
1970	25.2	28.4	28.4	33.2	47.7	57.2	63.5	63.6	49.5	40.3	32.9	20.9	40.9

(con.)

Table 24 (Con.)

McCall, ID (Con.)

Year	Mean temperature												
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	°F												
1971	23.2	24.3	26.0	37.3	49.2	52.4	62.3	65.1	48.3	40.9	31.0	22.6	40.2
1972	20.7	25.2	34.6	36.4	48.8	56.4	61.5	64.3	48.5	44.8	32.6	19.2	41.1
1973	20.2	26.3	31.9	39.3	50.0	55.9	63.7	61.0	52.1	43.0	30.8	27.7	41.8
1974	20.3	24.8	30.7	38.7	44.1	58.4	60.4	58.4	52.8	43.7	33.9	23.5	40.8
1975	20.6	21.8	28.2	31.4	43.8	51.2	65.4	56.2	52.1	41.3	29.6	27.4	39.1
1976	23.3	24.7	24.8	37.9	49.8	52.1	63.0	57.1	53.8	41.6	36.2	23.5	40.7
1977	18.7	29.1	28.4	43.9	44.3	60.8	61.5	61.9	50.4	41.4	30.9	27.8	41.6
1978	26.5	28.9	36.3	40.0	45.2	53.7	61.3	58.2	50.6	43.6	30.6	15.5	40.9
1979	11.0	26.2	32.4	37.9	48.1	55.6	62.9	62.4	55.9	45.6	27.9	27.6	41.1
1980	21.1	29.7	30.4	42.2	47.9	53.1	62.0	57.4	53.2	42.9	33.0	27.3	41.7
1981	27.1	25.9	34.7	40.1	46.4	52.6	60.6	64.1	54.1	40.3	34.8	26.8	42.3
1982	21.2	21.3	30.6	33.6	46.1	55.9	59.5	62.6	52.2	41.2	26.6	22.9	39.5
1983	26.6	28.3	34.4	36.7	48.0	54.6	59.8	64.2	50.9	44.3	32.5	18.0	41.5
1984	19.7	23.2	32.8	35.8	45.0	52.3	62.1	62.0	47.9	37.7	29.7	18.5	38.9
1985	15.8	18.3	27.9	41.8	50.1	56.7	65.5	57.2	47.9	40.2	23.5	16.8	38.5
1986	25.5	30.2	37.5	40.7	49.7	60.2	56.9E	62.8	45.3	41.9	31.9	23.2	42.2
1987	19.8	27.6	33.4	46.3	51.8	58.1	59.9	56.8	53.8				
10-year averages													
1921-30	17.0	23.2	28.4	37.4	48.0	54.9	63.3	61.2	51.7	43.4	31.1	20.9	40.0
1931-40	18.9	20.4	29.3	38.3	48.4	55.6	63.4	61.3	52.9	43.5	30.1	23.2	40.4
1941-50	15.9	22.6	28.0	37.8	46.7	52.5	61.9	59.9	51.5	42.9	30.2	22.2	39.3
1951-60	20.7	22.3	25.7	35.8	46.1	54.1	63.1	60.0	53.3	43.1	30.5	23.4	39.8
1961-70	21.8	26.2	28.9	37.6	47.8	56.1	62.9	61.9	53.4	43.6	32.9	24.1	41.4
1971-80	20.6	26.1	30.4	38.5	47.1	55.0	62.4	60.2	51.8	42.9	31.7	24.2	40.9
30-year averages													
1921-50	17.3	22.1	28.5	37.8	47.7	54.3	62.9	60.8	52.0	43.3	30.5	22.1	39.9
1931-60	18.5	21.8	27.7	37.3	47.1	54.1	62.8	60.4	52.6	42.8	30.3	22.9	39.9
1941-70	19.5	23.7	27.5	37.0	46.9	54.2	62.6	60.6	52.7	43.2	31.2	23.2	40.2
1951-80	21.0	24.9	28.3	37.3	47.0	55.1	62.8	60.7	52.8	43.2	31.7	23.9	40.7

(con.)

Table 24 (Con.)

Challis, ID - Observation time 1700, changed to 1500 in July 1961; 0800 beginning October 1973.[1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Mean temperature												
	°F												
1931	18.2	22.4	34.2	43.1	54.2	64.0	69.8	65.2	53.6	41.4	(25.0)	12.2	41.9
1932	(14.0)	(20.0)	33.8	42.9	50.4	59.1	64.4	63.8	57.0	45.3	35.0	12.2	41.5
1933	20.4	16.1	36.6	43.7	48.5	66.4	71.7	66.4	55.9	51.8	37.0	30.6	45.4
1934	30.0	36.2	44.0	50.7	58.1	60.1	69.0	69.4	54.6	50.7	37.6	24.4	48.7
1935	23.7	27.5	33.6	44.0	49.6	60.4	67.6	66.1	59.1	44.6	25.7	17.1	43.2
1936	17.6	21.0	33.4	46.1	56.8	62.4	71.5	66.1	55.3	46.4	29.2	24.6	44.2
1937	3.1	21.2	35.2	40.4	57.4	59.8	70.2	66.5	59.8	51.1	36.8	25.2	43.9
1938	20.7	28.8	35.4	46.5	51.5	60.8	66.2	65.8	62.0	45.8	28.8	26.2	44.9
1939	24.8	20.8	36.7	49.0	56.6	56.4	69.0	67.6	58.7	48.2	37.8	32.8	46.5
1940	21.4	28.3	40.6	45.8	57.3	65.4	69.2	68.4	56.5	49.0	28.8	26.3	46.4
1941	20.4	28.2	39.0	43.6	53.3	58.4	67.1	63.2	51.6	45.5	35.7	36.0	44.3
1942	9.8	15.6	28.8	45.7	46.6	55.4	68.3	67.2	58.0	47.0	32.2	22.6	41.4
1943	17.3	23.2	27.5	48.6	49.5	56.0	66.6	64.6	59.8	47.4	34.6	22.4	43.1
1944	15.2	25.6	30.4	44.0	52.6	55.4	64.0	62.8	56.9	50.0	30.4	17.8	42.1
1945	22.8	29.2	35.0	39.8	52.2	55.4	68.2	67.8	54.9	50.6	32.0	19.7	44.0
1946	23.0	25.1	37.5	47.2	51.4	61.2	68.2	65.2	54.6	40.4	32.6	27.6	44.5
1947	14.6	30.7	37.3	43.8	55.8	56.0	68.1	65.9	57.2	49.0	31.8	24.4	44.6
1948	22.6	28.2	32.0	42.5	52.2	61.1	65.1	64.8	58.0	47.0	30.5	12.9	43.1
1949	0.6	22.3	36.4	46.2	55.4	61.0	68.1	67.9	59.5	42.0	39.0	24.3	43.6
1950	20.6	28.7	35.5	42.8	49.6	58.8	67.0	65.0	55.9	50.0	36.0	26.2	44.7
1951	18.0	28.0	30.3	46.3	52.4	55.1	66.9	62.6	56.6	44.1	31.5	21.3	42.8
1952	16.0	19.3	27.0	46.7	53.7	60.4	66.4	66.3	60.5	50.4	27.3	20.4	42.9
1953	33.9	27.6	36.5	42.1	47.9	58.5	69.7	65.4	60.0	48.9	37.1	25.5	46.1
1954	27.3	33.3	32.6	46.1	55.5	57.0	69.4	63.4	57.8	(45.5)	38.1	18.6	45.4
1955	14.2	20.6	28.9	39.4	51.3	59.5	65.7	68.9	57.1	47.8	27.8	25.8	42.3
1956	20.4	16.8	33.2	45.1	54.3	61.2	67.9	63.8	58.7	45.0	27.0	24.4	43.2
1957	10.7	29.4	35.5	43.4	53.9	59.7	67.9	66.6	59.4	45.4	27.1	23.3	43.5
1958	16.2	28.6	31.2	41.3	58.7	60.9	66.0	69.0	58.3	48.6	33.7	(28.0)	45.0
1959	23.9	27.6	34.9	45.0	47.7	62.7	70.3	65.1	56.0	46.6	33.8	22.1	44.6
1960	15.2	18.6	32.4	46.1	51.4	63.2	73.0	65.6	61.7	47.7	33.6	22.6	44.3
1961	23.6	34.1	37.9	43.7	53.4	66.2	71.3	72.4	53.2	45.2	31.1	21.5	46.1
1962	16.0	26.1	32.1	48.1	51.9	61.4	66.4	64.6	59.8	49.1	35.6	27.5	44.9
1963	17.8	37.7	36.8	41.9	55.6	57.2	67.7	68.4	61.7	51.8	(33.0)	19.8	45.8
1964	17.8	21.8	29.7	44.2	53.2	58.8	71.3	65.2	56.2	48.9	32.9	23.6	43.6
1965	22.8	27.6	31.1	46.1	50.4	60.1	67.0	64.0	51.4	50.6	38.3	23.9	44.4
1966	25.0	27.3	36.8	46.3	58.7	61.3	70.7	68.2	62.6	47.8	35.9	23.3	47.0
1967	28.5	30.6	36.6	40.4	54.2	60.9	71.3	70.7	62.5	46.6	35.3	20.5	46.5
1968	20.1	30.4	41.8	43.8	52.1	60.9	69.8	62.8	56.3	45.3	33.7	22.4	45.0
1969	27.6	24.9	31.4	47.8	59.0	60.2	68.1	70.4	59.6	42.0	36.8	25.8	46.1
1970	26.8	34.6	34.8	39.4	54.4	64.3	69.5	70.5	54.1	43.7	35.0	20.5	45.6
1971	25.2	29.5	32.9	42.2	52.4	59.0	68.3	71.2	53.6	45.1	33.1	18.8	44.3
1972	20.6	26.9	39.9	42.1	54.2	65.2	69.3	70.2	56.8	48.2	33.1	15.6	45.2
1973	20.0	27.4	35.2	42.1	53.9	60.7	68.5	65.3	55.5	46.7	30.8	25.6	44.3
1974	17.5	28.0	32.6	44.9	49.5	65.9	69.3	63.7	58.1	46.2	32.1	22.0	44.2
1975	19.8	22.6	31.1	36.9	(49.0)	57.3	71.2	62.6	57.4	43.6	28.1	27.0	42.2
1976	20.5	23.7	29.5	41.9	54.3	58.4	69.6	61.0	56.5	44.3	32.9	23.7	43.0
1977	18.3	30.8	32.0	48.8	48.8	65.1	66.4	66.2	55.6	45.7	32.1	26.1	44.7
1978	23.9	25.7	38.6	44.5	48.3	60.1	66.5	64.0	55.4	47.7	30.5	16.9	43.5
1979	5.8	26.7	37.6	42.8	54.0	62.4	69.9	65.3	61.8	48.9	26.8	27.9	44.2
1980	18.4	27.8	34.4	46.9	52.4	58.5	68.1	63.2	55.9	44.7	33.8	29.8	44.5
1981	26.7	30.7	38.5	45.0	50.5	59.2	68.0	70.0	59.4	42.1	33.4	23.3	45.6
1982	17.1	21.0	35.8	37.6	51.4	60.1	65.6	68.5	55.2	41.7	27.9	21.8	42.0
1983	27.6	29.6	37.2	40.2	51.2	59.6	65.3	68.5	56.9	46.2	31.2E	8.8	43.5
1984	14.5	19.7	33.5	40.8	52.2	57.2	68.8	67.6	53.8	41.3	30.1	13.3	41.1
1985	15.7	16.4	28.8	47.8	54.2	63.1	73.4	64.3	50.6	43.6	21.8	7.2	40.6
1986	16.8	29.2	41.1	44.9	52.9	65.3	64.7	69.2	50.6	45.3	33.9	21.2	44.6
1987	21.2	28.7	36.9	49.9	55.5	62.2	64.4	63.5	60.5				

(con.)

Table 24 (Con.)
Challis, ID (Con.)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
	Mean temperature												
	°F												
10-year averages													
1931-40	19.4	24.2	36.4	45.2	54.0	61.5	68.9	66.5	57.3	47.4	32.2	23.2	44.7
1941-50	16.7	25.7	33.9	44.4	51.9	57.9	67.1	65.4	56.6	46.9	33.5	22.4	43.5
1951-60	19.6	25.0	32.3	44.2	52.7	59.8	68.3	65.7	58.6	47.0	31.7	23.2	44.0
1961-70	22.6	29.5	34.9	44.2	54.3	61.1	69.3	67.7	57.7	47.1	34.8	22.9	45.5
1971-80	19.0	26.9	34.4	43.3	51.7	61.3	68.7	65.3	56.7	46.1	31.3	23.3	44.0
30-year averages													
1931-60	18.6	25.0	34.2	44.6	52.9	59.7	68.1	65.9	57.5	47.1	32.5	22.9	44.1
1941-70	19.6	26.7	33.7	44.3	52.9	59.6	68.2	66.3	57.7	47.0	33.3	22.8	44.4
1951-80	20.4	27.1	33.8	43.9	52.9	60.7	68.8	66.2	57.7	46.7	32.6	23.1	44.5

[1]Change to 0800 observation time may result in an overall mean temperature decrease of at least 1.0 °F.

Table 25—Afternoon dry bulb temperature (°F) and relative humidity (percent) statistics for fire season. Based on years 1964-83; 1951-70 data included for comparison at Forest Service Northern Region stations (see text). Based mostly on 1300 m.s.t. observation time at Intermountain Region stations; 1600 m.s.t. through 1973 and 1300 thereafter at Northern Region stations. Letter M used as in table 21

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	9	65.5	6.3	64.0	75.0 71	56.7 75 M	88 69	78.9	6.6	78.0	41 68	49.8	6.1	50.0	MAY 1
MAY 11	9	68.1	7.0	67.0	83.3 73	58.9 77	91 73	83.0	6.1	85.0	42 75	51.3	6.6	49.0	MAY 11
MAY 21	10	70.9	5.7	70.5	79.9 69	61.8 78	98 66	85.0	6.6	84.0	46 78	52.7	4.7	53.5	MAY 21
JUN 1	13	75.0	6.4	72.0	85.8 65	68.3 71	100 69	88.0	7.3	88.0	53 71	59.3	6.1	57.0	JUN 1
JUN 11	13	76.1	6.2	76.0	87.6 74	65.5 76	99 65	90.5	6.0	92.0	49 73	60.2	6.5	61.0	JUN 11
JUN 21	13	79.8	6.3	79.0	89.1 74	64.9 69	104 70	93.1	6.3	96.0	48 70	60.7	10.7	55.0	JUN 21
JUL 1	15	86.1	7.0	89.0	96.9 68	73.4 77	103 68	95.3	7.0	98.0	56 77	71.9	8.1	73.0	JUL 1
JUL 11	15	88.8	5.0	91.0	95.6 66	78.9 76	108 67	99.2	5.0	100.0	55 72	74.0	8.6	76.0	JUL 11
JUL 21	15	91.1	4.8	91.0	97.5 69	82.4 76	108 68	99.7	4.8	100.0	61 75	75.5	9.8	74.0	JUL 21
AUG 1	15	91.2	6.0	92.0	97.6 69	76.5 76	111 66	99.9	6.9	100.0	65 74	77.5	7.6	79.0	AUG 1
AUG 11	15	87.1	10.4	88.0	101.5 67	69.0 68	106 70	98.0	7.1	100.0	54 74	73.4	14.3	76.0	AUG 11
AUG 21	15	83.0	9.6	80.0	98.5 70	70.2 77	108 69	93.6	9.2	94.0	53 64	68.1	11.8	66.0	AUG 21
SEP 1	15	78.9	6.5	77.0	93.4 66	70.2 70	101 69	90.9	6.7	91.0	53 64	61.9	7.9	59.0	SEP 1
SEP 11	14	70.2	6.0	72.0	80.8 67	60.3 78 M	93 67	81.6	6.6	81.5	47 68	56.6	6.7	54.5	SEP 11
SEP 21	12	71.7	7.0	70.5	86.1 67	60.9 72	99 67	82.2	7.9	81.0	42 68	56.6	8.9	57.5	SEP 21
OCT 1	9	64.5	5.4	64.0	70.6 66	55.5 69	80 64	75.1	4.1	75.0	45 70	52.0	6.8	51.0	OCT 1
OCT 11	7	59.8	4.9	60.0	66.5 72	53.3 68	76 64	67.9	5.1	67.0	41 68	50.4	7.3	51.0	OCT 11
OCT 21	7	54.3	4.0	53.0	59.0 64	47.5 70	68 72	63.3	4.9	64.0	41 70	44.9	4.7	43.0	OCT 21
MONTH															MONTH
MAY	8	68.5	5.2	69.0	75.3 69	61.0 78	98 66	86.0	4.1	86.0	41 68	48.0	4.2	48.5	MAY
JUN	13	77.0	3.4	76.0	82.5 74	69.4 76	104 70	96.0	4.7	96.0	48 70	54.2	4.2	54.0	JUN
JUL	15	88.7	4.6	90.0	94.1 67	80.7 77	108 68	100.9	4.7	100.0	55 72	66.7	6.8	67.0	JUL
AUG	15	87.0	7.4	84.0	98.1 67	76.3 76	111 66	101.1	6.9	100.0	53 64	65.1	10.2	62.0	AUG
SEP	12	73.9	5.6	72.0	85.5 67	67.3 70	101 69	91.2	6.3	91.0	42 68	53.4	7.1	53.0	SEP
OCT	7	59.4	3.3	59.0	64.6 64	55.7 69	80 64	75.4	4.7	78.0	41 70	43.3	3.6	42.0	OCT

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	9	39.1	8.3	38.0	55.6 75 M	28.2 71	93 75	74.2	14.9	72.0	12 71	17.4	5.9	14.0	MAY 1
MAY 11	9	38.1	10.5	40.0	51.7 78	16.4 73	87 70	67.0	18.0	75.0	8 73	17.3	5.9	15.0	MAY 11
MAY 21	10	35.2	6.3	36.0	43.1 77	23.5 69	94 66	70.0	14.2	70.5	11 74	17.0	5.0	16.0	MAY 21
JUN 1	13	37.0	8.9	38.0	50.5 71	24.2 73	90 77	69.5	19.3	77.0	9 73	17.2	4.8	17.0	JUN 1
JUN 11	13	37.6	10.1	40.0	55.8 76	23.5 69	89 74	76.0	15.1	82.0	12 69	18.8	5.3	19.0	JUN 11
JUN 21	13	33.0	7.9	32.0	53.5 69	21.1 74	93 70	64.2	19.7	71.0	10 77	14.9	3.0	15.0	JUN 21
JUL 1	15	27.3	9.7	25.0	51.0 78	14.5 66	83 77	52.0	19.3	51.0	8 72	15.5	9.5	13.0	JUL 1
JUL 11	15	25.5	8.3	23.0	46.8 76	14.8 66	95 76	49.0	19.5	46.0	5 73	13.1	6.0	12.0	JUL 11
JUL 21	15	21.8	7.5	19.0	37.4 76	12.6 66	90 76	50.3	23.3	56.0	6 73	10.7	4.7	9.0	JUL 21
AUG 1	15	21.3	9.1	19.0	46.8 76	9.0 69	85 74	43.9	19.2	39.0	6 64	11.3	5.8	9.0	AUG 1
AUG 11	15	25.9	15.5	25.0	58.4 68	8.3 73	89 68	50.5	28.8	56.0	5 73	11.5	6.8	9.0	AUG 11
AUG 21	15	27.9	12.3	30.0	47.5 75	9.9 69	89 77	60.0	27.0	65.0	5 69	13.8	8.2	10.0	AUG 21
SEP 1	15	29.8	9.3	28.0	46.6 70	12.8 66	95 70	63.0	25.2	65.0	5 66	15.1	7.0	13.0	SEP 1
SEP 11	14	37.1	12.6	35.5	61.7 68	16.0 71	94 78	68.2	23.7	76.5	9 71	19.6	8.0	18.5	SEP 11
SEP 21	12	33.9	8.7	34.0	47.5 76	18.2 74	92 68	67.5	21.9	74.5	7 74	18.6	8.5	17.0	SEP 21
OCT 1	9	44.0	11.2	47.0	58.8 69	27.2 78	93 75	76.3	17.5	81.0	16 64	24.7	5.8	24.0	OCT 1
OCT 11	7	42.2	9.7	40.0	60.0 68	32.4 69	93 75	70.9	14.5	69.0	13 64	23.7	6.4	24.0	OCT 11
OCT 21	7	53.7	5.9	55.0	61.0 66 M	44.2 72	93 70	81.3	12.2	84.0	31 72	36.6	5.0	36.0	OCT 21
MONTH															MONTH
MAY	8	36.8	6.6	37.0	45.1 77	26.0 73	94 66	79.5	8.8	80.0	8 73	14.1	4.3	13.0	MAY
JUN	13	35.9	4.5	35.0	43.3 76	27.5 74	93 70	85.1	4.9	87.0	9 73	13.8	3.1	14.0	JUN
JUL	15	24.8	7.4	23.0	38.9 76	13.9 66	95 76	64.9	18.3	63.0	5 73	10.1	4.8	8.0	JUL
AUG	15	25.1	10.1	26.0	42.2 76	11.2 69	89 77	69.8	23.8	85.0	5 73	9.9	6.1	8.0	AUG
SEP	12	32.7	7.3	31.5	46.1 68	21.1 74	95 70	76.3	18.7	81.5	5 66	12.1	5.7	10.5	SEP
OCT	7	46.7	5.6	49.0	53.6 68	39.1 64	93 75	88.4	4.4	88.0	13 64	21.7	5.7	22.0	OCT

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101019 HELLS HALF ACRE LO — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUL 1	14	61.3	5.3	62.0	69.5 75	53.2 77	80 73	72.6	4.3	73.5	31 81	46.4	8.6	46.5	JUL 1
JUL 11	20	63.2	5.1	63.0	70.7 66	52.3 83	79 67	73.3	3.9	74.5	29 83	48.1	8.9	47.5	JUL 11
JUL 21	20	66.5	4.1	66.5	73.7 66	59.4 77	81 66	75.1	3.2	75.0	42 75	55.6	8.3	56.0	JUL 21
AUG 1	20	66.2	5.1	66.0	71.8 71	54.7 76	83 66	75.2	4.3	76.5	36 80	54.9	8.4	57.0	AUG 1
AUG 11	19	63.2	7.2	64.0	75.6 67	47.6 78	81 71	72.7	5.3	73.0	29 64	50.8	10.4	52.0	AUG 11
AUG 21	18	60.3	8.1	61.5	71.5 70	46.5 77	83 69	71.6	6.8	71.0	28 64	45.9	10.6	47.5	AUG 21
SEP 1	14	57.3	5.8	57.5	66.9 66	48.2 64	77 73	69.0	5.2	69.0	32 64	40.7	8.1	37.0	SEP 1
MONTH															MONTH
JUL	14	63.8	3.8	64.0	69.6 66	57.3 83 M	81 66	76.6	2.7	77.0	29 83	42.2	7.4	42.5	JUL
AUG	18	63.3	5.3	64.0	72.4 67	54.5 75	83 69	76.6	4.2	77.5	28 64	43.3	8.8	44.5	AUG

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101019 HELLS HALF ACRE LO — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUL 1	14	47.7	9.2	45.0	62.4 78	37.3 67	100 83	80.3	14.4	81.5	19 67	26.0	6.3	25.5	JUL 1
JUL 11	20	45.3	12.1	43.0	69.5 75	24.1 66	100 83	76.2	20.4	79.0	13 66	26.4	11.3	23.5	JUL 11
JUL 21	20	39.9	10.4	38.5	56.2 77	17.1 66	100 76	68.8	21.1	73.0	9 66	23.2	7.8	22.0	JUL 21
AUG 1	20	39.0	12.4	37.5	65.7 74	19.3 69	100 74	64.2	23.1	65.5	11 67	21.8	7.8	20.0	AUG 1
AUG 11	19	42.1	16.2	43.0	64.5 78	16.5 67	100 78	70.5	24.6	79.0	10 67	22.1	8.6	23.0	AUG 11
AUG 21	18	45.8	16.1	44.5	71.6 77	20.2 69	100 77	79.7	18.0	83.5	8 66	25.2	11.6	26.0	AUG 21
SEP 1	14	44.9	12.1	42.5	63.1 64	22.6 66	100 75	78.4	20.8	83.5	8 66	24.7	9.4	24.0	SEP 1
MONTH															MONTH
JUL	14	43.5	9.8	41.0	57.0 65	26.0 66	100 83	89.9	8.5	93.5	9 66	19.9	5.7	19.0	JUL
AUG	18	42.3	12.5	44.0	61.9 65	20.5 67	100 78	85.1	16.0	87.0	8 66	17.6	6.3	16.0	AUG

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101019 HELLS HALF ACRE LO — 1954-1970

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUL 1	13	61.5	4.1	63.0	66.6 60	54.9 59	79 56	73.5	3.2	74.0	33 59	47.6	8.1	47.0	JUL 1
JUL 11	16	67.2	4.4	67.5	77.0 60	59.0 62	86 60	76.1	3.6	75.0	43 70	55.3	7.1	55.5	JUL 11
JUL 21	16	68.2	3.7	68.0	73.7 66	60.6 70	83 59	76.8	3.1	76.5	37 54	55.9	7.7	56.0	JUL 21
AUG 1	17	67.3	4.6	66.0	74.1 61	55.9 56	83 66	76.4	4.4	77.0	41 62	54.3	8.4	55.0	AUG 1
AUG 11	16	65.9	6.0	67.0	75.6 67	50.1 54	80 67	75.1	3.7	75.5	29 64	51.6	10.3	53.0	AUG 11
AUG 21	15	60.0	8.2	59.0	71.5 70	49.0 60	83 69	72.7	6.1	74.0	28 64	44.8	11.8	40.0	AUG 21
MONTH															MONTH
JUL	15	66.0	2.9	65.0	72.2 60	60.7 62	86 60	78.1	3.3	78.0	33 59	45.5	7.4	46.0	JUL
AUG	15	64.2	5.2	65.0	72.4 67	56.5 54	83 69	78.4	3.2	78.0	28 64	43.1	9.4	40.0	AUG

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101019 HELLS HALF ACRE LO — 1954-1970

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUL 1	13	48.0	10.4	46.0	68.9 58	33.4 60	94 70	79.9	14.7	86.0	15 61	26.2	8.4	24.0	JUL 1
JUL 11	16	39.3	10.7	42.0	60.3 65	20.8 60	94 55	65.2	20.4	70.0	9 60	21.9	8.0	22.0	JUL 11
JUL 21	16	36.8	9.4	37.0	51.5 65	17.1 66	92 54	67.5	18.7	70.5	9 66	19.7	6.4	18.5	JUL 21
AUG 1	17	38.0	12.2	35.0	58.2 65	19.3 69	100 62	69.2	25.1	76.0	11 67	19.2	5.8	19.0	AUG 1
AUG 11	16	37.3	14.3	35.5	71.2 54	16.5 67	100 65	68.6	25.5	69.0	10 67	20.0	7.4	18.5	AUG 11
AUG 21	15	46.4	17.2	51.0	70.7 54	20.2 69	100 64	83.3	22.2	93.0	8 66	19.6	7.5	17.0	AUG 21
MONTH															MONTH
JUL	15	41.3	8.8	42.0	57.0 65	26.0 66	94 70	86.3	8.7	91.0	9 66	17.6	5.9	18.0	JUL
AUG	15	40.8	12.6	42.0	61.9 65	20.5 67	100 65	89.1	17.6	93.0	8 66	16.0	5.0	16.0	AUG

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101032 RED RIVER RS

1964-1983

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
MAY 11	13	58.9	6.4	58.0	72.8 73	47.7 78	81 73	73.5	6.2	74.0	36 82	43.2	5.9	42.0	MAY 11
MAY 21	13	59.8	7.3	59.0	75.0 83	48.1 78	85 83	76.2	7.9	79.0	38 80	43.9	5.8	44.0	MAY 21
JUN 1	15	62.9	5.8	60.0	75.2 69	55.0 82	84 69	75.1	6.1	75.0	38 79	50.1	8.4	48.0	JUN 1
JUN 11	14	65.2	7.1	63.5	83.8 74	55.2 81	93 74	79.3	6.4	78.5	42 81	50.5	5.3	50.0	JUN 11
JUN 21	18	68.9	5.6	69.5	77.6 74	55.8 69	90 70	81.2	4.5	80.0	39 70	53.4	8.2	53.5	JUN 21
JUL 1	20	73.2	5.9	73.5	85.2 75	61.9 82 M	91 76	84.6	5.6	85.5	51 83	59.4	6.7	57.0	JUL 1
JUL 11	20	75.2	3.8	75.5	81.4 67	69.7 83	93 67	87.1	4.0	88.0	47 72	60.2	7.0	61.0	JUL 11
JUL 21	20	78.8	3.2	79.0	83.9 71	72.7 70	94 80	87.8	3.3	88.5	52 72	66.6	7.3	67.0	JUL 21
AUG 1	20	78.8	4.8	79.0	86.4 83	69.9 76	97 83	88.3	4.3	89.5	55 80	67.8	7.4	68.5	AUG 1
AUG 11	20	74.7	7.6	75.0	87.5 67	60.7 68	92 69	85.1	5.0	86.0	45 64	62.4	10.8	62.5	AUG 11
AUG 21	20	72.4	7.1	73.0	85.1 70	61.1 77	97 69	84.5	7.0	83.5	44 64	57.4	8.7	57.0	AUG 21
SEP 1	20	69.9	4.9	70.5	79.2 66	61.7 70	93 67	83.3	5.3	84.5	44 70	53.8	7.2	52.5	SEP 1
SEP 11	18	62.8	7.7	62.5	77.6 81	50.8 65 M	92 81	75.6	6.7	75.5	38 68	47.7	6.9	48.5	SEP 11
SEP 21	17	62.2	7.1	63.0	74.7 67	49.5 77	87 67	75.4	6.4	76.0	36 72	47.5	6.6	46.0	SEP 21
MONTH															MONTH
JUN	13	65.7	3.1	65.0	73.8 74	62.6 81 M	93 74	83.9	4.3	84.0	38 79	45.4	3.6	46.0	JUN
JUL	20	75.8	2.8	76.0	81.0 67	70.6 77	94 80	89.9	1.9	90.0	47 72	55.5	5.1	55.0	JUL
AUG	20	75.2	5.1	74.0	83.7 67	67.3 75	97 83	89.6	4.3	90.0	44 64	55.1	7.3	54.0	AUG
SEP	17	64.8	4.8	64.0	74.2 67	57.1 65 M	93 67	83.5	5.1	84.0	36 72	43.6	4.9	42.0	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101032 RED RIVER RS

1964-1983

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
MAY 11	13	47.5	12.8	45.0	69.1 78	26.4 64	100 70	79.9	18.7	85.0	9 83	22.8	8.3	24.0	MAY 11
MAY 21	13	50.2	13.5	51.0	75.3 80	29.6 83	100 80	82.8	14.2	86.0	16 79	23.9	7.0	21.0	MAY 21
JUN 1	15	49.1	12.8	51.0	64.7 66	25.5 65	94 64	76.9	17.8	83.0	15 78	25.7	8.0	25.0	JUN 1
JUN 11	14	49.8	7.8	50.5	62.3 70	36.1 69	100 81	82.5	11.7	86.0	15 65	23.4	5.2	23.0	JUN 11
JUN 21	18	46.4	8.4	46.5	66.2 69	31.9 79	100 78	80.7	13.0	85.0	10 76	22.4	6.8	21.0	JUN 21
JUL 1	20	41.2	10.1	39.0	59.8 78	26.6 73	95 77	70.4	16.0	71.0	9 79	21.1	8.2	19.0	JUL 1
JUL 11	20	39.6	6.8	38.5	55.0 75	27.6 73	95 76	71.8	15.4	68.5	13 65	19.6	5.4	18.0	JUL 11
JUL 21	20	34.0	7.4	33.5	45.0 83	18.9 66	95 76	60.9	19.9	59.0	9 66	19.4	6.1	19.5	JUL 21
AUG 1	20	33.4	8.0	32.0	52.0 74	20.6 69	94 74	58.4	19.7	56.5	8 64	18.1	4.9	18.0	AUG 1
AUG 11	20	39.5	13.9	39.5	70.6 68	20.9 67	100 68	67.7	23.2	70.5	9 73	20.5	7.2	21.0	AUG 11
AUG 21	20	39.8	12.2	38.0	65.6 77	19.5 70	100 73	72.6	19.7	72.0	9 69	19.5	6.5	20.0	AUG 21
SEP 1	20	39.5	7.1	37.5	53.6 70	28.3 66	100 72	72.4	16.1	70.5	12 76	20.1	5.5	20.0	SEP 1
SEP 11	18	45.4	13.0	44.5	75.8 68	25.9 71	100 77	76.1	18.6	81.5	11 81	23.3	6.8	21.5	SEP 11
SEP 21	17	47.3	10.7	48.0	71.4 77	30.4 75	100 69	78.9	16.9	85.0	8 70	24.9	9.3	22.0	SEP 21
MONTH															MONTH
JUN	13	48.4	4.9	49.0	55.7 70	40.6 78	100 81	92.2	5.7	93.0	10 76	18.5	4.4	19.0	JUN
JUL	20	38.1	6.3	38.5	49.6 77	27.6 73	95 77	81.4	13.5	84.5	9 79	15.4	3.8	15.5	JUL
AUG	20	37.6	8.4	38.5	48.5 68	22.2 69	100 73	80.9	16.8	84.5	8 64	15.1	4.7	13.5	AUG
SEP	17	44.5	6.5	44.0	54.4 77	34.3 67	100 77	89.0	10.9	93.0	8 70	17.2	5.8	18.0	SEP

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101032 RED RIVER RS — 1951-1970

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 11	10	58.4	5.5	58.5	67.4 64	47.7 62	84 54	73.2	7.3	74.5	37 65	41.7	4.9	40.0	MAY 11
MAY 21	13	60.4	6.1	59.0	69.8 63	51.5 54	87 56	74.6	6.8	74.0	39 64	44.9	5.0	44.0	MAY 21
JUN 1	18	63.1	6.9	61.0	75.2 69	52.6 54	85 57	76.8	7.5	77.0	41 62	50.0	7.7	48.0	JUN 1
JUN 11	19	65.9	5.5	66.0	78.3 59	56.7 57	91 61	79.4	5.2	79.0	40 57	51.8	6.4	51.0	JUN 11
JUN 21	20	67.0	6.0	66.0	77.9 61	55.8 69	91 61	81.6	7.0	82.5	39 70	51.4	7.3	49.5	JUN 21
JUL 1	20	74.1	5.9	74.5	81.8 53	58.5 55	90 70	85.6	5.2	87.5	43 55	59.9	7.9	59.5	JUL 1
JUL 11	20	78.3	4.6	78.5	85.2 60	69.5 63	95 53	89.3	4.1	90.0	51 68	65.0	7.7	64.5	JUL 11
JUL 21	20	79.7	3.7	79.5	84.8 61	72.7 70	96 59	89.1	3.6	89.0	54 54	67.3	6.7	67.0	JUL 21
AUG 1	20	78.0	4.4	78.5	86.6 61	69.1 56	101 61	88.6	4.7	89.0	53 56	65.4	7.8	67.0	AUG 1
AUG 11	20	76.8	6.5	77.5	87.5 67	60.7 68	93 61	86.6	4.5	87.0	45 64	64.8	9.7	65.0	AUG 11
AUG 21	20	71.6	6.9	70.0	85.1 70	61.3 60	97 69	86.1	6.6	84.5	40 60	57.6	9.4	58.0	AUG 21
SEP 1	19	71.1	5.6	72.0	81.7 55	61.7 70	93 67	83.9	5.8	84.0	44 70	55.6	6.7	58.0	SEP 1
SEP 11	16	64.0	7.3	63.0	76.3 53	50.8 65 M	89 53	79.8	6.0	80.0	37 61	46.8	7.2	46.5	SEP 11
SEP 21	11	68.1	8.0	67.0	79.1 63	55.8 65 M	88 63	80.5	6.2	82.0	41 68	51.1	9.5	48.0	SEP 21
MONTH															MONTH
JUN	18	65.1	2.7	65.0	69.9 60	59.7 53 M	91 61	84.9	3.7	85.0	39 70	45.3	4.1	46.0	JUN
JUL	20	77.4	2.9	76.5	83.1 60	72.5 55	96 59	91.1	2.7	90.5	43 55	57.6	7.0	57.0	JUL
AUG	20	75.3	4.5	74.0	83.7 67	69.0 54	101 61	90.9	4.4	91.5	40 60	56.3	8.0	58.0	AUG
SEP	11	67.5	6.2	69.0	74.2 67	57.1 65 M	93 67	85.0	5.2	87.0	37 61	45.0	5.4	46.0	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101032 RED RIVER RS — 1951-1970

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 11	10	49.9	14.6	47.5	73.8 57	26.4 64	100 70	86.6	13.7	89.5	11 64	23.9	9.6	24.0	MAY 11
MAY 21	13	50.0	10.3	51.0	63.4 54	32.5 63	94 57	85.4	11.1	88.0	16 56	23.8	7.5	21.0	MAY 21
JUN 1	18	51.4	12.6	50.0	70.4 58	25.5 65	94 64	78.9	17.7	85.5	15 65	26.4	8.9	25.5	JUN 1
JUN 11	19	48.3	8.4	47.0	62.3 70	32.0 59	94 62	78.9	14.0	87.0	12 61	24.1	5.5	23.0	JUN 11
JUN 21	20	45.8	10.0	45.0	66.2 69	29.3 60	100 51	82.5	16.3	87.0	11 64	22.0	6.9	21.0	JUN 21
JUL 1	20	39.9	10.5	37.5	65.0 58	20.9 53	99 55	68.2	20.6	65.5	12 68	20.3	6.1	19.0	JUL 1
JUL 11	20	35.1	7.3	35.0	48.9 57	21.8 61	99 57	66.1	22.3	68.0	11 61	17.9	3.9	18.0	JUL 11
JUL 21	20	31.9	7.6	30.5	44.9 55	18.9 66	86 56	57.8	17.8	58.5	7 61	16.6	5.1	17.0	JUL 21
AUG 1	20	34.3	9.3	34.0	56.6 58	20.6 69	99 58	62.4	23.2	64.5	8 64	16.9	5.6	15.5	AUG 1
AUG 11	20	34.5	12.8	31.0	70.6 68	20.9 67	100 68	61.9	23.6	62.0	10 51	18.6	5.4	19.0	AUG 11
AUG 21	20	39.9	12.2	40.0	61.6 51	19.5 70	100 65	73.8	21.9	78.5	7 55	16.2	5.7	16.0	AUG 21
SEP 1	19	37.5	8.1	37.0	54.6 57	26.2 62	94 70	69.8	17.9	72.0	11 55	18.7	6.4	18.0	SEP 1
SEP 11	16	45.6	14.0	46.0	75.8 68	22.2 53	100 68	79.6	20.7	86.0	8 53	19.2	6.6	17.0	SEP 11
SEP 21	11	39.2	12.5	36.0	58.8 65 M	20.9 52	100 69	73.5	21.8	85.0	8 70	19.7	7.6	20.0	SEP 21
MONTH															MONTH
JUN	18	49.0	5.8	48.5	59.8 58	35.8 60	100 51	90.1	5.7	93.0	11 64	19.0	4.3	19.0	JUN
JUL	20	35.5	6.8	34.5	46.5 55	23.4 53	99 57	80.4	17.6	83.5	7 61	14.5	3.5	15.0	JUL
AUG	20	36.3	8.2	36.5	48.5 68	22.2 69	100 68	81.5	17.6	89.0	7 55	12.4	3.3	13.0	AUG
SEP	11	41.1	8.2	43.0	52.1 65 M	28.3 52	100 69	89.6	8.9	92.0	8 70	14.9	5.6	13.0	SEP

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101033 RIGGINS RS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	19	65.6	6.1	65.0	81.1 66 M	54.4 64	95 66	80.4	5.9	80.0	40 64	49.7	6.1	52.0	MAY 1
MAY 11	19	69.4	6.2	68.0	84.0 73	58.0 74	94 73	84.0	5.4	86.0	43 75	54.5	5.8	54.0	MAY 11
MAY 21	19	71.5	5.7	69.0	86.2 83	62.6 80	97 66	86.7	6.1	86.0	46 71	55.1	6.4	54.0	MAY 21
JUN 1	19	74.3	5.9	72.0	83.7 69	65.9 82	98 70	86.2	5.8	87.0	48 76	61.0	7.1	60.0	JUN 1
JUN 11	20	75.5	6.0	73.5	91.1 74	66.4 81	104 74	89.1	5.7	89.0	50 75	60.4	6.2	60.0	JUN 11
JUN 21	20	79.4	5.9	79.5	87.8 74	67.0 69	103 70	93.1	6.9	93.5	48 75	64.6	8.9	62.0	JUN 21
JUL 1	20	84.0	6.2	84.0	96.6 68	74.8 78	105 73	94.9	5.2	95.0	56 81	71.0	8.9	70.0	JUL 1
JUL 11	20	86.2	4.2	85.5	92.8 73	79.9 80	108 67	97.1	5.5	98.0	57 72	72.4	6.6	74.0	JUL 11
JUL 21	20	90.2	4.0	91.0	96.5 71	82.1 75	103 73	98.6	3.3	98.0	60 75	77.6	9.6	78.5	JUL 21
AUG 1	20	90.9	5.2	91.5	100.3 71	80.1 76	109 71	99.2	5.0	98.0	62 76	79.6	9.1	80.0	AUG 1
AUG 11	20	86.8	8.0	86.0	101.3 67	72.5 68	106 71	97.4	5.3	98.5	57 78	74.6	11.1	71.5	AUG 11
AUG 21	20	83.1	7.0	82.5	95.8 70	71.3 75	110 69	95.1	7.9	94.0	56 64	68.9	8.9	69.5	AUG 21
SEP 1	20	80.4	5.2	80.0	90.9 67	71.7 70	104 67	92.1	5.7	91.0	54 70	66.3	8.5	66.0	SEP 1
SEP 11	19	72.9	6.6	74.0	85.4 81	61.9 78	98 81	84.7	6.6	86.0	47 68	58.7	6.8	57.0	SEP 11
SEP 21	19	72.3	6.4	72.0	85.3 67	60.2 77	95 67	82.3	6.2	82.0	50 68	59.9	6.7	60.0	SEP 21
OCT 1	16	69.0	7.5	69.5	80.0 65	57.8 81	89 71	79.1	6.7	81.0	49 81	58.0	8.3	56.5	OCT 1
OCT 11	15	61.8	4.5	61.0	68.2 78	55.3 69	84 64	71.3	6.4	71.0	43 66	52.4	5.6	53.0	OCT 11
MONTH															MONTH
MAY	19	68.9	3.6	67.0	76.1 66 M	64.2 75	97 66	88.7	4.7	88.0	40 64	47.6	4.6	48.0	MAY
JUN	19	76.4	3.5	76.0	83.5 74	71.3 75	104 74	95.2	5.2	94.0	48 76	55.8	4.9	55.0	JUN
JUL	20	86.9	3.5	86.0	92.9 73	81.3 83 M	108 67	100.3	3.7	100.0	56 81	65.9	6.3	66.0	JUL
AUG	20	86.8	5.2	86.5	96.0 67	76.4 75	110 69	100.6	5.6	99.5	56 64	65.1	7.0	63.5	AUG
SEP	19	75.2	4.5	73.0	85.5 67	68.5 70	104 67	92.1	5.1	90.0	47 68	55.8	5.3	54.0	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101033 RIGGINS RS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	19	38.9	6.4	37.0	55.2 64	30.6 66 M	94 73	71.0	14.6	70.0	9 73	19.6	6.8	20.0	MAY 1
MAY 11	19	35.0	8.8	36.0	50.2 69	15.5 73	87 74	59.7	18.5	60.0	8 73	17.7	5.3	16.0	MAY 11
MAY 21	19	35.5	8.3	35.0	51.8 80	22.5 83	100 81	67.7	18.5	66.0	6 66	17.8	5.3	19.0	MAY 21
JUN 1	19	37.1	10.2	42.0	49.7 64	19.4 79	88 82	63.1	19.9	68.0	9 79	19.6	6.2	20.0	JUN 1
JUN 11	20	38.0	6.4	35.0	50.3 64	29.7 74	89 80	70.8	15.2	71.0	8 79	19.2	6.3	20.5	JUN 11
JUN 21	20	32.8	8.6	33.5	49.9 69	19.8 77	82 69	57.8	17.8	62.0	7 73	14.9	5.3	14.0	JUN 21
JUL 1	20	29.1	9.4	26.5	48.6 78	13.4 73	73 77	48.5	15.1	44.5	6 73	16.4	7.9	14.0	JUL 1
JUL 11	20	27.6	7.0	25.5	44.0 75	15.7 73	81 76	48.4	15.2	45.0	7 73	15.7	7.6	14.5	JUL 11
JUL 21	20	22.7	5.8	22.0	36.4 75	14.7 69	86 77	44.8	21.1	39.0	6 73	13.4	4.4	13.5	JUL 21
AUG 1	20	21.7	7.0	20.5	36.9 76	12.7 72	86 65	39.1	21.1	32.5	6 71	13.3	4.1	13.5	AUG 1
AUG 11	20	25.9	11.7	25.5	48.8 68	11.0 77	95 79	47.9	26.9	45.0	5 73	13.4	5.3	13.5	AUG 11
AUG 21	20	28.1	9.6	28.0	46.5 75	11.2 70	89 65	54.8	22.8	48.5	5 70	13.9	7.0	13.0	AUG 21
SEP 1	20	27.8	7.5	25.5	41.7 78	16.4 66	94 78	53.5	23.4	45.0	6 66	14.1	4.9	[illegible].5	SEP 1
SEP 11	19	34.2	10.1	36.0	49.4 78	15.9 79	88 68	62.4	18.7	68.0	10 83	18.3	6.3	7.0	SEP 11
SEP 21	19	32.9	9.3	31.0	56.6 77	16.3 74	88 77	54.1	16.4	49.0	8 71	19.0	6.6	18.0	SEP 21
OCT 1	16	35.8	10.6	34.5	55.8 81	19.9 65	100 81	64.6	22.3	68.0	8 71	20.8	8.4	20.0	OCT 1
OCT 11	15	40.3	10.3	38.0	56.6 75	24.7 76	100 81	62.9	23.3	54.0	10 66	22.1	5.8	23.0	OCT 11
MONTH															MONTH
MAY	19	36.5	5.3	35.0	45.7 80	24.7 73	100 81	81.1	12.6	82.0	6 66	14.3	4.3	15.0	MAY
JUN	19	35.9	5.4	36.0	43.0 80	25.4 73	89 80	81.0	7.6	82.0	7 73	12.9	4.1	13.0	JUN
JUL	20	26.3	6.3	26.0	39.2 75	15.3 73	86 77	61.4	15.2	62.5	6 73	11.8	3.9	11.5	JUL
AUG	20	25.3	7.3	24.0	38.4 75	14.1 70	95 79	66.5	22.7	74.0	5 73	10.3	4.3	9.5	AUG
SEP	19	31.6	5.9	30.0	42.2 82	18.8 74	94 78	73.6	13.4	76.0	6 66	12.1	3.8	11.0	SEP

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101033 RIGGINS RS — 1951-1970

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG, YR	LOWEST AVG, YR	HIGH, YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW, YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	9	65.7	7.8	65.0	81.1 66 M	54.4 64	95 66	80.3	8.4	79.0	40 64	47.7	5.7	48.0	MAY 1
MAY 11	10	69.5	4.8	70.0	76.9 64	59.1 62	90 69	83.9	5.5	84.5	48 62	54.6	4.4	54.0	MAY 11
MAY 21	10	72.0	5.7	70.5	80.4 63	66.0 62	97 66	85.6	7.0	86.5	49 68	55.7	6.3	53.5	MAY 21
JUN 1	18	74.9	6.6	74.0	83.7 69	62.8 54	100 57	87.1	7.0	88.0	52 63	60.9	6.5	60.5	JUN 1
JUN 11	19	77.1	6.4	77.0	88.9 61	68.5 64	98 61	89.6	5.2	91.0	53 56	63.4	6.5	64.0	JUN 11
JUN 21	19	78.6	5.8	79.0	88.5 61	67.0 69	105 55	92.6	7.0	92.0	52 55	64.0	7.1	61.0	JUN 21
JUL 1	20	85.8	5.5	86.0	96.6 68	70.8 55	101 68	96.6	4.8	98.0	58 55	73.8	7.9	74.0	JUL 1
JUL 11	20	89.8	4.6	88.5	99.4 60	82.3 63	108 67	101.0	4.6	100.0	65 68	76.8	8.0	77.5	JUL 11
JUL 21	20	91.8	3.8	92.0	98.1 51	84.3 70	109 59	100.2	3.9	100.0	66 64	79.8	7.8	82.0	JUL 21
AUG 1	20	90.3	4.1	90.0	98.2 61	80.3 62	110 61	99.9	4.1	99.5	61 62	77.3	9.0	79.0	AUG 1
AUG 11	20	89.4	6.5	90.0	101.3 67	72.5 68	105 67	99.1	4.3	100.0	52 60	77.3	11.8	81.0	AUG 11
AUG 21	20	83.2	7.1	81.5	95.8 70	71.5 60	110 69	96.9	7.9	97.5	52 60	68.6	10.1	69.0	AUG 21
SEP 1	20	82.7	5.9	82.0	93.8 55	71.7 70	104 67	94.6	5.1	95.0	54 70	69.1	7.6	70.5	SEP 1
SEP 11	19	75.0	6.7	74.0	89.2 53	62.9 70	101 53	89.3	6.0	90.0	47 68	58.7	7.3	57.0	SEP 11
SEP 21	18	75.6	8.0	74.5	88.8 63	60.9 59	97 63	85.9	7.8	84.0	45 54	61.6	8.9	61.5	SEP
OCT 1	13	69.9	7.0	71.0	80.0 65	58.6 69	92 63	81.2	6.3	81.0	46 62	57.0	8.2	55.0	OCT 1
OCT 11	10	63.6	6.5	63.0	72.8 63	55.3 69	84 64	73.8	7.9	74.5	43 66	53.5	6.3	54.5	OCT 11
MONTH															MONTH
MAY	9	69.2	4.0	68.0	76.1 66 M	63.5 62	97 66	87.9	6.2	88.0	40 64	46.6	4.5	48.0	MAY
JUN	18	77.0	3.4	77.0	85.5 61	70.7 54	105 55	95.8	4.8	95.5	52 63	57.6	4.9	57.0	JUN
JUL	20	89.2	3.0	88.5	95.2 60	83.2 55	109 59	102.8	3.6	100.0	58 55	70.8	6.7	70.0	JUL
AUG	20	87.5	4.3	86.5	96.0 67	81.5 60	110 69	102.8	3.8	100.0	52 60	65.5	8.3	63.0	AUG
SEP	18	77.7	5.3	78.0	85.5 67	68.5 70	104 67	95.3	4.7	95.5	45 54	56.0	6.1	55.5	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101033 RIGGINS RS — 1951-1970

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG, YR	LOWEST AVG, YR	HIGH, YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW, YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	9	42.4	8.0	42.0	55.2 64	30.6 66 M	92 64	76.9	9.3	78.0	11 70	19.9	8.6	18.0	MAY 1
MAY 11	10	38.3	9.1	37.5	52.7 62	24.2 65	94 61	67.9	17.6	66.0	12 65	20.5	6.7	19.5	MAY 11
MAY 21	10	38.0	8.3	39.5	46.7 62	22.5 66	99 68	69.0	17.4	72.5	6 66	18.5	7.3	18.5	MAY 21
JUN 1	18	39.7	8.9	40.5	53.3 63	23.2 65	88 64	66.3	17.0	69.0	11 70	21.4	6.1	21.0	JUN 1
JUN 11	19	37.6	7.9	35.0	52.2 56	25.7 61	95 58	64.1	18.0	56.0	11 68	20.1	5.1	19.0	JUN 11
JUN 21	19	33.2	8.5	35.0	49.9 69	18.7 60	93 55	60.7	19.5	64.0	9 55	16.1	5.1	16.0	JUN 21
JUL 1	20	26.0	7.0	24.5	43.1 55	14.6 68	83 55	44.4	14.3	42.5	7 68	14.8	5.1	13.0	JUL 1
JUL 11	20	23.9	6.5	23.5	38.3 56	12.4 61	85 56	43.6	18.6	40.0	5 61	11.9	3.9	12.0	JUL 11
JUL 21	20	20.1	5.4	18.0	30.5 56	13.5 61	71 64	35.8	13.8	31.0	7 61	11.4	3.5	11.0	JUL 21
AUG 1	20	22.2	7.2	21.0	37.0 62	12.9 69	99 62	43.4	23.6	38.0	7 61	12.8	4.4	13.5	AUG 1
AUG 11	20	21.9	8.9	19.5	48.8 68	12.3 70	89 54	43.4	25.7	33.0	7 67	11.9	4.5	11.0	AUG 11
AUG 21	20	26.5	9.1	26.0	41.2 65	11.2 70	89 65	55.3	23.4	52.5	5 70	12.5	5.2	11.5	AUG 21
SEP 1	20	24.4	6.7	23.0	39.6 64	14.6 62	88 70	42.6	18.4	37.5	6 66	11.7	3.4	11.5	SEP 1
SEP 11	19	33.1	10.1	34.0	49.4 59	15.7 51	99 55	65.1	21.1	68.0	7 52	14.1	4.4	13.0	SEP 11
SEP 21	18	29.7	8.1	29.0	50.2 59	14.9 52	93 54	54.7	19.3	49.5	9 65	15.6	6.0	15.0	SEP 21
OCT 1	13	34.4	9.7	34.0	49.2 69	17.1 52	87 70	65.2	20.6	75.0	7 52	17.8	6.8	18.0	OCT 1
OCT 11	10	38.1	10.1	35.5	56.5 68	21.5 52	94 67	59.4	16.4	60.0	10 66	21.3	7.2	23.0	OCT 11
MONTH															MONTH
MAY	9	39.1	4.7	39.0	47.4 62	30.6 66 M	99 68	82.7	11.[illegible]	82.0	6 66	13.9	3.7	15.0	MAY
JUN	18	36.7	5.5	37.5	42.4 58	25.3 60	95 58	77.3	13.7	79.0	9 55	14.[illegible]	3.6	15.0	JUN
JUL	20	23.2	5.5	21.5	36.9 56	15.6 61	85 56	53.4	14.7	50.0	5 61	9.[illegible]	2.9	10.0	JUL
AUG	20	23.6	6.2	22.0	34.5 65	14.1 70	99 62	64.2	24.0	67.0	5 70	[illegible].6	3.9	9.0	AUG
SEP	18	29.2	5.7	29.0	42.0 59	19.9 51	99 55	74.7	14.5	74.0	6 66	9.6	2.0	10.0	SEP

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101801 BONANZA GS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS — 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 11	7	63.7	4.3	65.0	69.9 82 M	57.2 73	82 68	74.7	4.1	76.0	40 73	52.7	8.6	53.0	JUN 11
JUN 21	14	67.8	6.2	67.0	76.3 74	51.6 69	87 79	79.4	4.9	80.0	39 68	52.4	10.2	48.5	JUN 21
JUL 1	18	70.8	6.2	72.0	80.1 68	57.0 82 M	91 73	80.6	6.5	81.0	45 69	57.4	7.4	56.5	JUL 1
JUL 11	20	74.7	3.3	75.0	80.8 66	67.2 83	89 68	83.3	3.5	84.0	51 80	63.1	7.2	64.5	JUL 11
JUL 21	20	77.3	3.3	76.0	85.8 68	72.4 73	92 68	84.3	3.2	84.5	52 75	65.9	7.8	66.0	JUL 21
AUG 1	20	76.4	4.6	77.0	81.8 78	64.6 76	90 83	84.1	3.6	85.0	45 74	64.6	8.7	67.0	AUG 1
AUG 11	20	72.6	6.5	72.0	82.5 67	61.5 78	87 81	81.6	3.7	82.0	42 78	60.4	10.5	57.0	AUG 11
AUG 21	19	70.2	6.0	70.0	79.5 67	59.5 77	87 81	79.3	4.7	80.0	42 77	56.6	9.3	56.0	AUG 21
SEP 1	18	69.3	4.8	70.5	76.6 66	59.7 70	85 76	79.3	4.0	79.5	41 73	55.3	8.9	56.0	SEP 1
SEP 11	15	62.8	7.4	61.0	76.9 81 M	48.1 78	83 81	74.3	5.9	76.0	35 78	47.7	8.3	46.0	SEP 11
SEP 21	11	61.2	8.7	60.0	71.9 67	47.2 72	80 67	71.9	6.3	71.0	35 71	47.1	10.6	43.0	SEP 21
MONTH															MONTH
JUL	19	74.6	2.9	74.0	80.8 68	69.3 83	92 68	86.5	2.3	86.0	45 69	55.3	6.1	54.0	JUL
AUG	19	72.9	3.9	71.0	79.9 67	66.6 76	90 83	84.9	2.4	85.0	42 78	52.6	8.3	50.0	AUG
SEP	11	64.9	4.9	63.0	71.6 79	56.9 72	85 76	79.7	2.7	79.0	35 78	42.5	7.9	40.0	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101801 BONANZA GS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS — 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 11	7	38.8	8.0	37.0	49.4 73	29.8 68	93 73	64.1	16.3	59.0	12 77	21.3	5.2	24.0	JUN 11
JUN 21	14	38.6	12.2	39.5	60.3 69	20.8 74	92 69	67.2	22.3	75.5	10 76	20.6	8.0	19.0	JUN 21
JUL 1	18	32.3	13.2	29.5	67.5 82 M	16.4 73	100 70	63.7	24.6	60.0	8 73	16.8	10.6	14.5	JUL 1
JUL 11	20	29.5	7.9	29.0	44.4 78	17.1 66	84 73	54.8	18.3	57.0	10 79	15.4	5.6	14.0	JUL 11
JUL 21	20	26.2	6.9	24.0	40.1 78	15.7 68	100 77	54.6	21.2	48.5	6 72	14.4	4.9	13.5	JUL 21
AUG 1	20	26.2	8.4	24.5	42.4 74	14.0 72	100 74	54.1	25.7	55.0	5 79	13.6	4.1	13.0	AUG 1
AUG 11	20	30.2	11.6	25.5	52.5 68	16.7 67	95 79	55.6	23.1	59.0	5 71	14.1	5.5	13.0	AUG 11
AUG 21	19	30.0	8.5	30.0	43.6 73	17.3 81	93 77	61.5	22.5	69.0	9 72	15.3	5.0	14.0	AUG 21
SEP 1	18	28.2	8.3	27.0	49.0 70	18.6 66	87 80	53.4	21.7	53.5	8 72	14.2	4.0	14.0	SEP 1
SEP 11	15	34.4	13.5	34.0	56.3 78	14.2 79	100 78	63.8	21.4	66.0	9 74	15.9	6.3	13.0	SEP 11
SEP 21	11	34.6	11.7	31.0	50.5 83	16.9 74	100 83	62.5	27.5	62.0	7 74	16.6	5.0	16.0	SEP 21
MONTH															MONTH
JUL	19	29.2	7.7	28.0	47.0 82 M	19.7 72	100 77	75.6	17.8	81.0	6 72	12.2	3.5	12.0	JUL
AUG	19	29.2	6.3	28.0	39.6 83	18.2 67	100 74	77.0	19.5	83.0	5 79	10.8	2.8	12.0	AUG
SEP	11	31.2	7.1	33.0	41.8 78	19.7 74	100 83	79.5	15.4	84.0	7 74	11.4	3.4	11.0	SEP

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101204 CASCADE RS — 1964-1983

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	12	56.3	7.7	55.5	70.6 66	46.9 75 M	81 66	67.2	7.4	68.0	35 70	43.7	8.0	43.0	MAY 1
MAY 11	14	58.7	6.7	58.0	74.7 73 M	49.1 78 M	80 73	69.9	6.5	71.0	37 67	47.4	7.0	47.5	MAY 11
MAY 21	15	63.0	6.2	63.0	76.9 83 M	49.0 78 M	83 83	75.6	5.3	75.0	37 78	50.3	6.4	51.0	MAY 21
JUN 1	15	65.1	6.3	63.0	75.0 69	55.1 67	84 69	75.1	5.8	75.0	44 66	53.6	8.2	52.0	JUN 1
JUN 11	18	65.5	5.4	65.5	73.9 82 M	56.5 64	85 68	76.2	6.6	78.0	42 83	53.1	7.3	54.0	JUN 11
JUN 21	18	70.9	5.5	71.0	81.3 73 M	55.2 69	89 70	82.8	4.8	83.0	43 70	58.6	8.5	61.0	JUN 21
JUL 1	18	75.9	5.4	76.5	84.0 68	65.6 78	95 73	85.2	4.3	85.5	53 83	64.6	6.9	64.0	JUL 1
JUL 11	20	77.9	3.5	77.5	82.7 67	70.3 83	94 67	86.4	4.0	87.5	54 83	66.3	6.5	67.0	JUL 11
JUL 21	20	80.9	2.5	80.5	84.5 80	76.2 76	93 80	88.3	2.6	88.5	60 77	71.4	6.3	73.5	JUL 21
AUG 1	18	79.5	4.1	80.5	83.9 66	68.0 76	94 83	87.0	3.6	88.0	57 76	70.3	6.6	71.5	AUG 1
AUG 11	19	76.0	7.1	76.0	88.6 67	61.6 68	92 67	85.5	4.1	85.0	48 68	64.1	11.0	63.0	AUG 11
AUG 21	19	73.1	6.4	71.0	84.4 70	62.2 77	94 69	83.3	5.2	82.0	48 64	61.9	8.7	60.0	AUG 21
SEP 1	19	71.7	4.7	72.0	80.2 66	63.6 70	88 73	81.4	4.6	82.0	46 70	58.5	7.2	58.0	SEP 1
SEP 11	19	64.5	6.2	66.0	77.0 81 M	52.7 78 M	87 81	75.5	5.2	76.0	38 68	50.3	7.0	50.0	SEP 11
SEP 21	17	62.8	6.7	62.0	74.3 67	50.7 77	85 66	72.3	6.8	72.0	41 82	50.7	6.7	50.0	SEP 21
OCT 1	15	59.6	6.3	58.0	70.3 79	50.4 69	78 79	69.7	4.6	70.0	39 75	49.2	8.0	46.0	OCT 1
OCT 11	15	53.6	5.2	54.0	60.7 78	43.8 68	71 79	62.7	5.4	64.0	38 68	44.7	6.3	42.0	OCT 11
OCT 21	12	48.3	5.5	49.0	55.6 65	36.1 70 M	65 83	57.9	6.7	58.5	31 70	40.1	5.8	40.0	OCT 21
MONTH															MONTH
MAY	11	60.7	2.9	59.0	66.3 66	57.0 68	83 83	77.6	3.3	77.0	35 70	40.9	4.9	42.0	MAY
JUN	15	67.0	2.6	66.0	71.7 73 M	61.5 71	89 70	83.8	3.1	83.0	42 83	47.3	4.6	46.0	JUN
JUL	18	78.3	2.7	78.0	82.4 66	71.4 83 M	95 73	90.2	2.7	90.0	53 83	62.3	6.0	62.0	JUL
AUG	18	76.1	4.5	74.0	84.5 67	69.4 76	94 83	88.6	2.8	88.5	48 68	58.9	7.5	57.0	AUG
SEP	17	66.7	4.0	65.0	73.0 67	60.2 65 M	88 73	82.2	4.2	82.0	38 68	47.1	5.7	46.0	SEP
OCT	12	54.5	4.3	55.0	59.4 78 M	46.6 70 M	78 79	70.7	4.3	70.0	31 70	38.7	3.4	39.0	OCT

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101204 CASCADE RS — 1964-1983

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	12	41.6	10.1	41.0	59.3 75 M	27.2 66	86 83	70.5	12.9	71.5	11 66	22.8	7.6	21.0	MAY 1
MAY 11	14	42.1	12.9	40.5	69.4 78 M	18.7 73 M	93 68	64.4	21.5	62.5	8 70	22.5	10.2	22.5	MAY 11
MAY 21	15	40.3	10.2	40.0	64.3 78 M	25.1 83 M	100 78	69.9	17.2	68.0	17 70	21.7	3.3	22.0	MAY 21
JUN 1	15	42.4	10.8	43.0	65.2 67	25.8 65	94 67	66.9	20.7	76.0	11 65	22.6	8.2	20.0	JUN 1
JUN 11	18	42.8	10.9	39.5	65.8 64	26.6 79 M	89 65	68.1	16.7	70.0	9 71	22.9	8.6	21.5	JUN 11
JUN 21	18	37.7	10.5	37.0	65.0 69	23.3 81 M	94 71	62.4	19.6	60.0	6 73	19.8	5.9	20.0	JUN 21
JUL 1	18	31.1	8.2	30.5	52.3 78	19.1 73	89 82	52.2	16.6	50.5	5 73	18.5	6.4	18.5	JUL 1
JUL 11	20	30.0	6.9	28.0	43.5 75	20.7 79	80 76	49.4	15.4	47.5	13 79	19.1	5.9	18.0	JUL 11
JUL 21	20	26.2	5.6	27.0	39.0 76	14.9 66	84 77	47.1	16.6	48.0	6 73	15.4	4.0	16.0	JUL 21
AUG 1	18	26.1	8.5	22.5	51.8 76	17.8 69	89 65	43.6	19.8	36.0	10 79	15.7	4.3	16.5	AUG 1
AUG 11	19	31.5	12.8	27.0	57.5 68	15.2 70	100 65	56.9	27.2	48.0	7 70	17.2	6.1	16.0	AUG 11
AUG 21	19	32.7	10.4	32.0	48.5 77	16.3 70	93 64	58.3	23.0	58.0	9 70	17.7	6.2	17.0	AUG 21
SEP 1	19	31.4	8.8	30.0	53.5 78	17.1 66	93 73	56.1	23.3	47.0	6 66	18.6	6.6	18.0	SEP 1
SEP 11	19	38.7	10.0	38.0	56.5 80	20.1 79 M	94 80	68.2	21.1	66.0	9 69	20.4	8.6	19.0	SEP 11
SEP 21	17	39.9	11.1	36.0	62.9 77	25.6 75	93 77	65.0	18.3	69.0	9 65	21.9	9.0	20.0	SEP 21
OCT 1	15	39.4	10.6	35.0	59.0 67	23.8 65	92 67	65.1	21.3	70.0	9 79	22.3	7.6	23.0	OCT 1
OCT 11	15	46.3	8.3	43.0	66.5 68	35.3 78	100 64	72.3	18.1	75.0	16 66	29.3	8.4	28.0	OCT 11
OCT 21	12	53.7	12.8	55.0	74.3 70 M	28.9 78 M	100 76	74.4	19.0	74.0	9 72	35.0	14.2	35.5	OCT 21
MONTH															MONTH
MAY	11	39.0	5.3	39.0	46.8 80 M	31.7 66	100 78	81.3	10.5	85.0	8 70	16.8	5.2	18.0	MAY
JUN	15	41.5	6.2	39.0	53.2 71	33.6 73 M	94 71	82.8	10.3	86.0	6 73	16.2	5.3	17.0	JUN
JUL	18	28.9	5.9	27.0	41.4 78	20.3 66	89 82	61.1	15.6	57.5	5 73	14.4	4.1	14.0	JUL
AUG	18	29.9	8.7	28.5	46.1 76	17.4 70	100 65	68.3	24.6	71.5	7 70	14.0	4.6	13.0	AUG
SEP	17	35.9	5.9	36.0	46.7 80 M	27.2 79 M	94 80	81.4	12.9	86.0	6 66	14.3	4.4	14.0	SEP
OCT	12	46.2	6.3	45.0	54.8 69	32.2 78 M	100 76	84.6	15.5	92.0	9 79	18.6	6.9	19.0	OCT

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101803 CHALLIS RS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS — 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	7	62.2	9.6	63.0	79.1 66	51.4 64	88 66	75.0	7.5	76.0	39 65	46.7	8.6	44.0	MAY 1
MAY 11	8	64.7	5.5	64.0	73.6 64	56.4 71	82 70	77.3	4.2	78.0	40 71	51.5	8.5	51.5	MAY 11
MAY 21	11	65.5	5.4	64.0	75.2 69	57.0 78 M	86 67	79.0	5.1	80.0	43 78	51.5	6.8	51.0	MAY 21
JUN 1	16	68.5	6.6	67.0	78.4 77	60.0 82 M	90 69	79.3	6.2	80.0	44 71	56.8	7.4	57.0	JUN 1
JUN 11	17	69.9	4.2	70.0	75.2 79	61.2 64	88 79	80.7	4.7	81.0	49 76	58.8	4.9	60.0	JUN 11
JUN 21	18	74.5	6.1	74.5	83.1 73	58.9 69	93 79	86.3	6.0	88.0	47 68	58.7	8.0	58.5	JUN 21
JUL 1	19	78.5	5.7	79.0	86.1 73	66.6 82	97 81	87.5	4.9	88.0	52 69	65.5	8.9	67.0	JUL 1
JUL 11	20	81.9	3.5	81.5	89.4 66	73.4 83	95 66	89.8	3.1	89.5	59 83	70.8	5.9	71.5	JUL 11
JUL 21	20	83.3	3.0	82.5	87.9 80	78.5 77	95 80	90.4	2.8	91.0	58 72	72.6	7.2	73.0	JUL 21
AUG 1	20	82.1	4.3	82.0	89.0 79	70.6 76	94 79	90.1	3.1	90.5	52 74	70.6	7.7	72.0	AUG 1
AUG 11	20	78.6	6.7	78.5	88.0 67	64.0 68	93 71	87.9	3.8	89.0	52 78	66.3	10.4	63.5	AUG 11
AUG 21	20	76.3	6.1	75.0	86.3 67	67.6 65	95 69	85.6	4.9	85.0	52 73	64.9	8.5	65.5	AUG 21
SEP 1	20	74.0	3.9	73.0	81.0 66	67.4 70	90 69	83.8	3.2	84.0	51 73	61.1	6.3	60.5	SEP 1
SEP 11	20	65.7	6.1	66.0	77.7 81 M	54.5 65	87 73	78.4	4.9	79.0	36 65	51.2	8.1	52.5	SEP 11
SEP 21	19	65.2	6.2	66.0	75.3 67	54.7 71	89 66	76.3	5.3	76.0	38 71	51.2	7.8	53.0	SEP 21
OCT 1	15	63.5	5.7	63.0	73.4 65	53.0 69	82 65	74.6	4.2	75.0	42 75	50.2	6.7	47.0	OCT 1
OCT 11	13	57.6	5.6	58.0	68.7 73	46.8 69	78 73	69.3	6.7	70.0	36 69	46.8	6.8	45.0	OCT 11
OCT 21	7	52.6	5.4	54.0	57.2 66	41.5 71	66 64	63.9	2.7	65.0	24 71	40.0	7.6	43.0	OCT 21
MONTH															MONTH
MAY	7	65.1	4.5	63.0	71.4 66	60.5 71	88 66	81.9	4.6	82.0	39 65	42.4	3.6	40.0	MAY
JUN	15	70.8	2.4	70.0	76.2 77	66.8 64	93 79	87.9	3.3	88.0	44 71	50.9	3.8	50.0	JUN
JUL	20	81.4	3.0	81.0	86.4 64	74.8 83	97 81	92.5	2.1	92.5	52 69	62.6	6.2	62.0	JUL
AUG	20	78.9	4.3	77.5	86.1 69	71.6 76	95 69	90.9	2.8	91.0	52 78	60.8	7.5	60.0	AUG
SEP	19	68.4	3.9	67.0	75.6 79	61.4 65	90 69	84.3	3.3	84.0	36 65	46.8	7.2	46.0	SEP
OCT	7	56.8	3.6	55.0	61.1 64	51.4 69	82 65	73.1	3.6	76.0	24 71	38.7	7.3	42.0	OCT

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101803 CHALLIS RS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS — 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	7	28.1	9.6	24.0	47.4 64	19.2 69	71 70	53.4	16.5	53.0	8 66	15.7	6.6	16.0	MAY 1
MAY 11	8	24.7	6.6	23.5	33.5 71	14.6 64	60 70	46.0	14.4	50.0	8 69	12.6	3.7	12.0	MAY 11
MAY 21	11	31.7	8.7	31.0	47.7 78 M	17.7 69	90 78	61.9	21.4	68.0	12 69	15.0	2.8	14.0	MAY 21
JUN 1	16	31.3	10.4	28.0	50.9 64	17.8 76 M	87 68	57.3	21.0	58.0	5 77	16.8	6.9	16.5	JUN 1
JUN 11	17	29.6	7.9	30.0	46.5 64	16.3 78	94 76	52.4	18.0	47.0	8 79	17.5	4.9	18.0	JUN 11
JUN 21	18	28.0	10.6	23.0	50.1 69	16.0 81 M	94 71	57.3	20.7	55.5	6 79	13.7	6.4	12.0	JUN 21
JUL 1	19	24.9	7.4	25.0	37.9 82	10.2 73	94 70	51.1	20.6	49.0	5 73	11.6	4.1	11.0	JUL 1
JUL 11	20	22.1	9.1	18.5	45.7 83	9.5 66	69 67	41.1	15.7	43.0	5 69	12.4	6.3	11.0	JUL 11
JUL 21	20	21.2	5.4	19.0	33.9 83	13.1 66	85 77	45.8	16.1	42.0	7 65	10.7	3.3	10.0	JUL 21
AUG 1	20	22.3	7.9	22.5	35.4 83	9.0 69	85 70	47.3	23.7	48.5	5 79	10.8	3.4	10.5	AUG 1
AUG 11	20	25.9	10.9	22.0	45.9 68	13.1 70	89 79	48.8	23.2	46.5	7 70	12.3	4.4	11.5	AUG 11
AUG 21	20	24.2	6.8	23.0	35.5 83	11.2 69	73 83	44.4	15.7	44.5	6 69	12.0	3.1	11.5	AUG 21
SEP 1	20	23.1	6.0	20.5	34.3 78	15.8 83	75 73	42.6	14.5	39.5	8 79	12.3	3.0	11.5	SEP 1
SEP 11	20	30.1	8.7	29.0	44.3 82 M	15.4 79	85 82	54.4	19.6	57.5	6 69	15.2	5.3	14.0	SEP 11
SEP 21	19	28.6	7.5	27.0	42.9 82 M	16.9 70	84 71	49.4	18.2	49.0	10 74	16.1	4.1	16.0	SEP 21
OCT 1	15	26.0	8.4	24.0	42.0 67	14.5 79	85 67	46.9	18.9	50.0	6 76	15.7	6.5	15.0	OCT 1
OCT 11	13	29.7	6.4	30.0	39.2 79	21.3 70	82 79	50.2	16.4	47.0	5 75	16.2	5.6	15.0	OCT 11
OCT 21	7	30.9	8.6	29.0	47.8 71	19.7 78 M	89 71	52.9	21.6	46.0	6 66	18.1	7.3	17.0	OCT 21
MONTH															MONTH
MAY	7	27.1	4.9	29.0	32.1 71	20.1 69	90 78	69.1	12.2	72.0	8 69	10.7	2.8	12.0	MAY
JUN	15	30.3	5.6	29.0	41.6 82 M	19.0 78	94 76	74.1	16.5	78.0	5 77	11.7	3.8	12.0	JUN
JUL	20	22.6	6.0	23.0	37.3 83	13.5 66	94 70	60.1	16.7	61.5	5 73	8.9	2.6	9.0	JUL
AUG	20	24.2	6.6	23.0	38.7 83	11.5 69	89 79	64.9	17.2	65.0	5 79	9.3	2.5	9.5	AUG
SEP	19	27.1	5.0	25.0	35.1 82 M	17.5 79	85 82	64.6	14.6	67.0	6 69	11.6	2.9	11.0	SEP
OCT	7	28.8	5.8	27.0	36.3 71	20.6 78 M	89 71	66.4	18.9	64.0	5 75	13.6	3.6	15.0	OCT

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101303 INDIANOLA RS 1964-1983

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	17	61.0	5.3	59.0	70.5 71	52.0 64	80 70	73.1	4.3	72.0	35 65	47.3	6.9	45.0	MAY 1
MAY 11	18	65.7	7.5	65.5	79.4 73	51.5 74	90 73	78.8	7.3	78.5	43 83	52.6	7.4	50.0	MAY 11
MAY 21	17	66.5	4.7	67.0	74.8 69	57.3 80	87 83	80.6	3.7	81.0	41 80	51.5	5.8	52.0	MAY 21
JUN 1	19	72.5	5.7	72.0	81.7 65	63.1 64	90 77	83.7	4.4	83.0	49 82	58.2	7.2	55.0	JUN 1
JUN 11	19	72.6	6.8	72.0	90.8 74	61.5 76	98 74	84.7	6.6	84.0	49 76	58.8	7.0	58.0	JUN 11
JUN 21	20	77.4	5.8	76.5	87.7 74	63.0 69	96 73	88.9	4.5	88.5	49 70	62.6	9.5	59.5	JUN 21
JUL 1	19	81.9	6.5	82.0	91.0 73	66.3 83 M	99 73	91.8	4.1	92.0	53 83	66.8	8.9	68.0	JUL 1
JUL 11	20	85.4	4.5	85.5	96.1 66	74.9 83	100 79	94.0	3.6	93.0	54 83	71.6	9.1	73.5	JUL 11
JUL 21	20	88.0	3.6	88.0	94.7 66	81.0 70	103 66	94.9	3.4	95.0	63 77	77.2	7.5	77.0	JUL 21
AUG 1	20	86.8	4.2	87.5	91.8 79	76.0 76	100 71	94.8	3.8	95.5	62 64	75.8	7.3	78.0	AUG 1
AUG 11	20	83.0	7.7	81.5	94.5 67	68.1 68	99 66	92.9	4.3	93.5	47 78	69.6	12.4	67.0	AUG 11
AUG 21	20	79.2	6.5	78.5	89.0 67	68.6 75	97 66	89.4	5.7	89.5	48 64	64.8	8.8	64.0	AUG 21
SEP 1	20	76.8	4.8	75.0	87.7 66	68.7 70	95 66	86.9	3.5	87.0	53 73	62.8	8.0	60.5	SEP 1
SEP 11	20	68.4	6.4	68.0	82.8 81	58.5 65 M	92 81	81.3	4.6	81.5	40 65	52.9	6.8	53.5	SEP 11
SEP 21	20	67.3	6.8	67.0	78.1 67	57.4 77	89 66	76.4	6.2	76.5	42 68	55.6	8.0	55.0	SEP 21
OCT 1	16	63.6	6.8	63.0	73.8 65	51.1 82	80 79	72.4	6.3	75.0	44 82	53.4	6.2	53.0	OCT 1
OCT 11	11	57.5	5.8	57.0	63.9 74	46.8 69	78 64	66.9	6.2	67.0	37 80	47.5	7.0	47.0	OCT 11
OCT 21	11	52.1	4.3	53.0	58.3 64	43.9 70 M	70 73	62.8	5.5	64.0	32 71	40.9	5.1	40.0	OCT 21
MONTH															MONTH
MAY	16	64.9	4.1	64.5	71.9 69	57.1 78	90 73	82.6	4.1	83.0	35 65	45.2	5.2	44.5	MAY
JUN	19	74.2	3.4	74.0	82.9 74	69.3 76	98 74	90.2	4.0	90.0	49 82	52.8	3.4	52.0	JUN
JUL	19	85.3	3.6	85.0	92.7 66	76.0 83 M	103 66	96.4	2.9	96.0	53 83	63.5	6.8	62.0	JUL
AUG	20	82.9	4.7	81.5	90.2 67	75.8 76	100 71	95.6	3.4	96.0	47 78	62.4	9.3	60.0	AUG
SEP	20	70.9	4.5	69.0	78.5 79	64.0 65 M	95 66	87.4	3.3	87.0	40 65	50.1	5.3	49.5	SEP
OCT	10	57.1	3.6	57.5	63.3 64	52.0 69	80 79	73.1	4.6	74.5	32 71	40.0	3.7	39.0	OCT

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101303 INDIANOLA RS 1964-1983

10-DAY AND MONTHLY PERIOD MEANS							10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	17	37.1	8.3	37.0	52.6 75	21.2 69	93 75	64.6	19.0	64.0	11 65	18.8	4.6	20.0	MAY 1
MAY 11	18	33.7	10.3	33.5	55.0 81	17.1 73	100 74	61.6	21.0	60.5	6 73	17.4	6.9	18.5	MAY 11
MAY 21	17	37.1	9.5	37.0	58.8 80	21.3 69	100 64	71.4	20.3	70.0	9 72	18.5	5.7	18.0	MAY 21
JUN 1	19	34.6	9.6	34.0	58.4 64	17.7 65	94 72	64.1	19.8	64.0	9 73	17.6	4.5	19.0	JUN 1
JUN 11	19	36.0	9.5	34.0	53.7 76	21.8 74	100 75	66.2	18.8	71.0	6 79	18.1	7.3	16.0	JUN 11
JUN 21	20	31.4	7.7	30.0	44.3 82	19.3 77	87 70	57.9	18.8	63.0	7 68	16.1	5.6	14.5	JUN 21
JUL 1	19	29.3	10.8	30.0	56.1 83 M	9.8 73	95 83	60.6	25.8	60.0	6 73	13.4	4.4	13.0	JUL 1
JUL 11	20	25.3	8.3	25.0	40.8 83	8.9 66	90 67	48.3	22.4	43.0	5 66	14.4	5.9	13.5	JUL 11
JUL 21	20	22.2	6.3	21.0	33.8 77	9.4 66	95 77	45.1	20.4	40.0	5 66	12.6	4.2	12.0	JUL 21
AUG 1	20	23.5	8.6	21.0	44.2 76	11.6 69	89 64	44.8	19.5	37.5	5 72	12.5	5.9	9.5	AUG 1
AUG 11	20	29.4	13.9	31.0	50.1 79	12.0 66	100 78	56.9	30.0	55.5	5 77	14.3	6.1	15.0	AUG 11
AUG 21	20	30.7	10.1	29.0	47.7 75	12.2 69	98 83	61.4	22.9	56.0	5 66	15.9	6.3	15.0	AUG 21
SEP 1	20	29.2	8.8	27.0	47.6 70	14.1 66	85 70	52.4	18.2	51.0	8 71	15.5	5.8	14.5	SEP 1
SEP 11	20	36.1	10.3	36.5	56.3 80	18.4 71	94 76	65.4	18.2	66.5	5 70	19.7	7.9	18.5	SEP 11
SEP 21	20	36.3	10.0	35.5	55.7 77	18.1 74	100 77	63.6	20.3	63.5	8 74	21.4	7.5	21.5	SEP 21
OCT 1	16	33.2	10.3	31.0	49.4 75	18.4 79	94 75	52.8	17.9	48.5	10 74	21.4	6.0	23.0	OCT 1
OCT 11	11	41.2	9.6	42.0	56.9 80	26.9 74	100 80	72.5	18.5	74.0	14 64	24.6	7.5	24.0	OCT 11
OCT 21	11	45.9	6.1	44.0	55.7 82 M	35.6 64	100 74	79.8	15.7	77.0	20 80	25.1	6.4	24.0	OCT 21
MONTH															MONTH
MAY	16	35.7	7.5	35.0	47.4 81 M	22.5 73	100 74	81.0	16.0	87.5	6 73	14.6	5.3	14.5	MAY
JUN	19	34.0	5.9	33.0	43.3 64 M	25.7 74	100 75	79.8	11.8	83.0	6 79	13.2	4.9	13.0	JUN
JUL	19	25.3	6.7	26.0	40.7 83 M	11.9 66	95 83	73.1	20.3	74.0	5 66	10.5	3.2	10.0	JUL
AUG	20	28.0	8.8	28.5	45.4 76	13.3 69	100 78	74.6	22.6	83.0	5 77	11.2	5.5	9.0	AUG
SEP	20	33.9	7.5	34.0	48.5 80	23.5 79	100 77	75.4	14.2	78.0	5 70	14.3	6.0	12.5	SEP
OCT	10	40.6	5.9	41.0	48.7 82 M	30.1 64	100 80	88.4	12.3	91.5	10 74	19.5	4.8	20.5	OCT

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101206 KRASSEL RS

1964-1983

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	7	60.5	7.8	61.0	70.1 71 M	50.6 77 M	79 80	72.6	6.9	76.0	39 75	49.4	9.3	48.0	MAY 1
MAY 11	9	65.0	8.1	62.0	80.9 73	54.3 78 M	88 73	79.2	5.8	81.0	35 67	48.7	10.5	42.0	MAY 11
MAY 21	9	65.1	6.3	68.0	70.6 71	55.8 78 M	86 71	81.9	4.2	83.0	40 79	46.9	5.1	48.0	MAY 21
JUN 1	12	69.8	4.5	69.0	76.8 77	63.8 71	91 77	81.7	6.2	82.5	42 78	51.3	5.5	51.0	JUN 1
JUN 11	14	70.5	5.3	71.0	77.4 82 M	59.3 81 M	91 68	83.2	5.7	85.0	46 81	54.9	6.6	52.5	JUN 11
JUN 21	16	74.8	5.3	74.0	83.6 77	60.5 69	96 70	87.8	5.0	88.5	43 70	57.7	8.8	56.0	JUN 21
JUL 1	18	81.4	6.9	82.5	93.1 68	70.6 83	102 73	91.4	5.4	92.0	48 77	67.3	10.2	67.0	JUL 1
JUL 11	20	83.5	4.4	83.0	89.9 70	73.5 83	100 67	92.9	4.4	93.5	53 83	68.6	9.4	70.0	JUL 11
JUL 21	20	86.7	3.4	86.0	92.4 66	81.2 76	99 69	93.9	2.9	94.5	61 77	74.7	8.4	75.5	JUL 21
AUG 1	20	86.1	4.6	86.5	91.4 72	73.5 76	100 66	93.7	3.7	94.0	55 76	74.2	8.5	76.0	AUG 1
AUG 11	20	81.8	8.2	82.0	94.9 67	64.6 68	98 71	91.4	4.3	91.0	50 74	69.0	13.1	66.5	AUG 11
AUG 21	20	78.5	7.6	76.0	91.0 67	64.5 77	101 69	88.8	6.4	88.0	50 64	64.6	10.7	62.5	AUG 21
SEP 1	19	76.6	5.2	77.0	86.0 66	66.1 64	95 67	87.0	5.1	87.0	50 78	62.8	8.5	62.0	SEP 1
SEP 11	18	68.0	6.6	67.5	80.0 81 M	54.3 78 M	90 73	80.5	6.1	80.5	43 78	52.8	6.5	50.0	SEP 11
SEP 21	13	65.6	6.5	65.0	76.7 79	55.8 81	85 79	76.8	4.9	76.0	42 81	53.8	9.3	49.0	SEP 21
OCT 1	7	62.5	6.7	62.0	73.0 79	52.3 81 M	79 79	72.3	4.5	73.0	41 82	50.0	9.7	45.0	OCT 1
MONTH															MONTH
MAY	8	64.7	4.8	65.5	70.5 73	56.3 77 M	88 73	84.3	2.1	84.0	35 67	43.6	6.0	42.0	MAY
JUN	9	71.9	3.1	72.0	77.7 77	68.3 76 M	96 70	90.2	3.0	90.0	42 78	50.2	4.2	50.0	JUN
JUL	19	84.1	3.7	85.0	88.5 68	75.6 83	102 73	95.6	3.2	96.0	48 77	61.8	6.8	63.0	JUL
AUG	20	82.0	5.3	79.5	91.9 67	74.8 76	101 69	94.6	3.6	94.5	50 74	61.9	9.9	60.5	AUG
SEP	13	69.9	4.0	69.0	77.6 74 M	64.9 70	95 67	85.4	4.1	85.0	42 81	50.8	6.7	49.0	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101206 KRASSEL RS

1964-1983

	10-DAY AND MONTHLY PERIOD MEANS						10-DAY AND MONTHLY EXTREME DAILY VALUES								
PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	7	39.0	10.0	42.0	48.3 77 M	27.9 76 M	93 80	64.7	21.1	57.0	13 73	17.9	3.8	18.0	MAY 1
MAY 11	9	33.1	14.1	34.0	54.1 78 M	14.1 73	91 67	62.1	27.1	63.0	6 73	16.9	7.8	19.0	MAY 11
MAY 21	9	34.6	10.9	30.0	54.2 80	22.6 73	98 79	70.7	21.0	60.0	10 73	16.2	4.1	15.0	MAY 21
JUN 1	12	34.0	9.4	38.5	44.6 68	18.6 73	100 75	74.4	24.1	85.5	11 73	15.5	5.0	13.0	JUN 1
JUN 11	14	35.3	7.9	32.0	48.1 81 M	24.6 68	89 80	69.0	17.6	72.0	9 79	17.4	4.4	16.5	JUN 11
JUN 21	16	33.1	8.9	31.5	49.8 69	17.9 77	100 79	71.5	21.6	76.0	6 76	14.9	4.9	13.5	JUN 21
JUL 1	18	24.9	10.7	21.5	49.2 78 M	11.7 73	100 82	49.6	26.5	42.0	7 73	12.8	4.9	11.5	JUL 1
JUL 11	20	22.6	6.1	21.5	33.4 64	12.1 69	89 76	51.3	24.3	46.0	8 76	12.9	3.8	12.0	JUL 11
JUL 21	20	20.5	5.9	20.0	34.7 77	10.6 66	93 77	44.6	21.1	38.5	7 66	11.4	3.2	10.5	JUL 21
AUG 1	20	19.7	7.2	17.0	36.5 76	9.5 69	90 71	41.3	24.3	31.0	6 78	10.6	2.9	10.0	AUG 1
AUG 11	20	24.8	12.8	23.0	58.0 68	9.3 70	100 79	49.9	28.6	47.5	6 70	11.9	4.3	11.0	AUG 11
AUG 21	20	26.9	10.9	24.0	48.6 77	11.5 69	100 64	54.9	24.7	48.5	5 65	12.5	5.3	12.0	AUG 21
SEP 1	19	26.2	10.1	23.0	51.7 78	13.8 66	94 78	48.2	24.2	36.0	6 66	13.8	4.5	14.0	SEP 1
SEP 11	18	35.7	13.4	37.5	54.9 77 M	14.5 71	100 80	66.8	27.6	76.5	9 71	16.4	5.2	16.0	SEP 11
SEP 21	13	35.0	11.4	37.0	57.0 82 M	15.3 74 M	93 83	59.8	26.2	52.0	6 72	20.7	8.1	19.0	SEP 21
OCT 1	7	35.4	17.0	30.0	64.4 81 M	17.8 79	93 81	67.3	26.0	79.0	9 74	20.1	9.5	18.0	OCT 1
MONTH															MONTH
MAY	8	33.9	9.5	32.0	48.1 80	21.9 73	98 79	78.3	18.3	87.0	6 73	13.5	4.5	14.0	MAY
JUN	9	32.7	5.4	33.0	41.2 80	25.9 73	100 79	85.6	13.5	88.0	6 76	11.9	4.0	12.0	JUN
JUL	19	22.4	5.9	20.0	34.1 80 M	14.9 66	100 82	64.3	21.6	66.0	7 73	9.8	2.8	9.0	JUL
AUG	20	23.9	8.0	22.5	37.[illegible] 83 M	12.4 69	100 79	67.7	24.6	72.0	5 65	8.8	2.7	8.0	AUG
SEP	13	31.0	8.5	30.0	40.6 82 M	15.3 74 M	100 80	74.7	22.7	84.0	6 72	12.5	3.5	12.0	SEP

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101207 LANDMARK RS

1964-1981

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 21	10	65.7	4.6	66.0	70.6 73	59.6 80 M	82 70	77.6	3.7	78.5	38 70	51.2	8.1	49.5	JUN 21
JUL 1	15	69.9	5.1	70.0	78.4 68	59.3 78 M	88 73	78.8	5.3	79.0	44 81	56.9	7.4	59.0	JUL 1
JUL 11	18	72.8	3.5	72.0	78.4 66	66.4 80 M	87 79	81.3	3.7	81.5	46 72	60.3	7.4	62.0	JUL 11
JUL 21	18	75.7	3.0	75.0	79.4 69	70.4 70	89 75	82.6	2.9	82.5	51 73	64.9	8.0	67.5	JUL 21
AUG 1	18	74.3	4.6	74.5	79.6 78	63.0 76	87 70	81.8	3.3	83.0	49 64	63.0	7.3	64.0	AUG 1
AUG 11	18	70.3	8.3	70.0	83.2 67	54.9 68	88 67	79.7	5.2	81.5	43 68	59.7	12.0	60.0	AUG 11
AUG 21	18	67.7	7.4	65.5	79.8 67	55.2 77	87 69	78.2	5.4	76.5	41 64	54.8	10.1	52.5	AUG 21
SEP 1	18	66.0	5.4	66.5	75.0 66	57.5 65	84 67	77.3	4.1	78.0	41 70	52.2	8.3	53.0	SEP 1
SEP 11	18	59.0	7.0	59.0	72.6 81 M	45.2 78 M	83 81	70.6	6.1	71.0	29 65	43.3	7.0	42.5	SEP 11
SEP 21	12	59.2	8.6	61.0	71.9 67	45.3 77	82 66	70.0	6.9	71.0	31 72	45.1	9.1	44.5	SEP 21
OCT 1	9	57.4	8.0	58.0	69.4 79	45.4 67	75 79	67.8	8.5	68.0	34 75	42.9	7.4	42.0	OCT 1
MONTH															MONTH
JUL	16	72.9	2.2	72.5	76.2 66	68.6 77	89 75	84.1	2.1	84.0	44 81	52.9	6.4	51.5	JUL
AUG	18	70.7	5.2	68.0	80.2 67	63.3 76	88 67	83.4	2.9	83.5	41 64	51.8	8.8	49.5	AUG
SEP	12	61.8	5.6	60.5	68.4 67	52.8 65	84 67	77.4	4.2	77.5	29 65	40.9	8.2	39.5	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101207 LANDMARK RS

1964-1981

10-DAY AND MONTHLY PERIOD MEANS | 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
JUN 21	10	35.1	9.9	34.0	51.3 70 M	24.6 77 M	93 68	60.6	20.4	64.5	13 79	19.7	6.9	17.5	JUN 21
JUL 1	15	31.2	8.6	32.0	55.3 78 M	22.0 79	87 78	56.9	18.3	53.0	12 68	19.3	7.0	18.0	JUL 1
JUL 11	18	29.8	6.7	29.0	43.0 75	18.2 66	87 72	55.3	19.3	55.0	11 79	17.3	4.5	16.0	JUL 11
JUL 21	18	25.0	4.8	24.0	35.7 76	15.3 66	94 77	49.0	18.6	45.0	9 72	14.3	3.1	14.0	JUL 21
AUG 1	18	25.6	8.2	24.0	43.5 76	14.6 69	89 81	51.9	23.3	52.0	7 79	13.9	4.0	14.0	AUG 1
AUG 11	18	32.0	13.0	28.5	61.0 68	14.7 67	93 68	55.9	25.0	48.0	7 80	15.9	6.0	16.0	AUG 11
AUG 21	18	33.0	10.3	32.0	50.6 77	17.2 67	93 73	62.8	25.0	60.0	10 67	16.8	4.1	16.0	AUG 21
SEP 1	18	31.9	9.5	28.5	52.0 78	18.4 66	93 73	59.5	24.3	52.5	8 69	15.9	4.1	16.5	SEP 1
SEP 11	18	41.4	12.5	44.0	60.6 76	14.1 79 M	94 76	74.0	21.1	83.0	12 79	20.1	8.3	17.5	SEP 11
SEP 21	12	37.0	12.3	35.5	61.8 77	20.2 74	100 77	69.5	24.4	69.5	13 71	19.8	5.6	18.5	SEP 21
OCT 1	9	38.1	16.0	31.0	65.3 67	16.4 79	94 75	64.2	24.4	72.0	11 64	20.4	13.8	15.0	OCT 1
MONTH															MONTH
JUL	16	28.1	4.2	27.0	34.8 78 M	19.5 66	94 77	72.3	15.6	76.5	9 72	13.3	2.6	13.5	JUL
AUG	18	30.3	7.6	28.5	42.3 76	16.5 67	93 73	74.0	21.6	84.5	7 80	11.8	3.4	11.0	AUG
SEP	12	35.3	7.8	33.5	44.9 77	24.0 79 M	100 77	84.5	13.3	88.5	8 69	13.9	2.9	13.0	SEP

(con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101805 LITTLE CREEK GS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 21	8	63.1	5.2	63.0	69.8 79	56.2 80	88 66	78.1	5.6	78.5	40 78	45.9	4.4	44.5	MAY 21
JUN 1	16	70.6	6.6	71.5	80.0 77	59.3 82 M	93 77	81.6	5.9	82.5	44 66	56.3	8.2	55.0	JUN 1
JUN 11	16	71.4	6.0	70.5	87.2 74	60.2 81	95 74	83.8	5.8	83.0	44 81	56.6	6.8	57.0	JUN 11
JUN 21	17	75.6	6.2	75.0	85.9 74	59.7 69	96 79	87.5	5.7	88.0	46 70	61.1	9.7	61.0	JUN 21
JUL 1	19	79.8	6.1	80.0	89.3 75	70.0 78	99 73	90.4	4.7	90.0	51 83	64.9	9.0	65.0	JUL 1
JUL 11	20	83.2	4.0	82.0	90.1 66	73.3 83	97 79	91.8	3.6	92.0	49 83	69.0	8.7	70.5	JUL 11
JUL 21	20	86.2	3.2	85.5	91.1 68	80.0 77	97 75	93.2	2.5	93.5	62 77	75.6	7.0	74.5	JUL 21
AUG 1	20	84.5	5.2	85.0	91.3 66	70.6 76	98 71	92.1	4.5	92.0	56 74	73.2	8.2	72.5	AUG 1
AUG 11	20	80.4	7.7	80.0	93.0 67	66.3 68	98 71	89.8	4.8	90.0	53 74	67.4	11.4	65.5	AUG 11
AUG 21	19	76.9	6.9	73.0	90.1 67	67.5 77	95 66	86.9	5.4	85.0	49 77	63.0	9.0	63.0	AUG 21
SEP 1	19	74.6	5.2	74.0	82.7 66	66.0 70	94 67	84.9	4.3	86.0	50 73	60.4	7.8	60.0	SEP 1
SEP 11	18	66.1	6.4	66.0	79.0 81 M	54.1 78	85 81	78.4	5.1	80.0	38 65	50.1	7.3	48.5	SEP 11
SEP 21	12	66.3	7.2	66.0	79.2 67	55.4 81	89 66	75.6	7.5	76.0	42 81	52.9	6.6	51.0	SEP 21
MONTH															MONTH
JUN	15	72.7	3.5	72.0	80.0 74	68.0 80 M	96 79	89.7	4.9	91.0	44 81	50.1	5.4	49.0	JUN
JUL	19	83.1	3.3	83.0	87.9 66 M	75.3 83	99 73	94.9	2.3	95.0	49 83	61.4	6.7	61.0	JUL
AUG	19	80.2	5.3	78.0	90.4 67	71.7 76	98 71	92.6	3.4	92.0	49 77	60.6	8.4	56.0	AUG
SEP	12	69.3	4.9	68.5	77.0 67	62.7 65	94 67	84.7	4.7	85.0	38 65	47.7	6.3	48.0	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101805 LITTLE CREEK GS — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 21	8	41.6	9.7	41.0	60.5 80	25.5 79	100 80	81.9	12.3	82.0	13 66	20.0	6.8	17.5	MAY 21
JUN 1	16	33.4	10.4	30.5	52.9 81 M	19.9 79	87 81	60.1	21.0	59.5	7 73	17.7	8.1	16.0	JUN 1
JUN 11	16	33.0	8.4	33.0	49.6 81	17.3 74	100 81	65.4	18.4	67.0	6 79	16.4	7.1	15.0	JUN 11
JUN 21	17	29.4	8.2	30.0	52.4 69	15.9 74	88 69	55.1	17.9	50.0	7 74	15.2	5.2	14.0	JUN 21
JUL 1	19	26.6	10.3	24.0	47.5 78	13.1 73	100 69	55.6	25.2	51.0	5 73	13.0	5.1	12.0	JUL 1
JUL 11	20	23.9	6.6	22.5	38.3 67	13.8 79	81 67	50.4	20.1	52.5	8 79	13.0	4.0	11.5	JUL 11
JUL 21	20	20.7	6.4	19.5	32.5 77	12.3 68	85 77	41.6	18.1	39.0	6 72	12.3	3.9	11.0	JUL 21
AUG 1	20	22.5	10.3	20.0	45.9 76	8.8 69	95 74	45.0	23.5	42.5	6 72	12.1	6.3	10.5	AUG 1
AUG 11	20	26.0	12.4	25.5	47.6 79	10.0 70	100 79	50.7	27.7	46.0	5 72	12.9	6.2	13.5	AUG 11
AUG 21	19	27.6	9.6	25.0	42.2 77	14.3 67	94 65	58.4	20.3	55.0	5 67	13.0	4.8	13.0	AUG 21
SEP 1	19	27.9	8.4	24.0	44.6 73	18.9 81	94 80	53.7	23.9	43.0	5 72	14.0	4.0	14.0	SEP 1
SEP 11	18	36.2	11.0	34.0	53.2 80	16.8 79	92 64	68.9	19.6	73.5	10 83	18.0	6.6	17.5	SEP 11
SEP 21	12	34.6	10.6	33.0	51.3 73 M	19.5 75	100 67	62.8	26.0	67.5	11 67	19.4	7.2	17.5	SEP 21
MONTH															MONTH
JUN	15	32.0	6.3	31.0	43.8 81 M	21.1 79	100 81	78.8	13.0	80.0	6 79	11.9	4.8	11.0	JUN
JUL	19	23.7	6.2	22.0	36.4 83	15.7 79	100 69	70.1	14.6	73.0	5 73	10.7	3.6	10.0	JUL
AUG	19	25.9	8.7	25.0	42.6 83	12.7 72	100 79	69.9	20.6	73.0	5 72	9.4	4.3	9.0	AUG
SEP	12	33.0	7.6	33.0	45.4 73 M	23.1 74	100 67	80.4	15.8	84.0	5 72	13.3	3.0	13.0	SEP

(con.)

Table 25 (Con.)

DRY BULB TEMPERATURE

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101209 MC CALL SO — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	11	51.3	5.4	51.0	60.9 76 M	44.6 77 M	75 69	64.3	5.5	62.0	28 75	39.5	6.7	40.0	MAY 1
MAY 11	16	57.9	5.7	56.5	72.8 73	50.2 81 M	80 73	70.3	5.7	70.5	38 78	45.5	5.4	44.0	MAY 11
MAY 21	16	59.5	6.3	60.0	74.1 83	50.5 78 M	85 66	73.9	7.0	74.0	35 78	45.8	6.4	45.0	MAY 21
JUN 1	17	64.3	5.7	65.0	73.7 69	54.0 82	87 77	76.1	5.5	75.0	38 78	51.1	8.2	49.0	JUN 1
JUN 11	17	63.1	5.7	62.0	73.7 82	53.7 81	83 68	75.8	6.3	78.0	40 81	48.4	7.9	46.0	JUN 11
JUN 21	19	68.2	4.9	68.0	74.9 77	54.7 69	87 73	80.4	5.0	81.0	43 78	52.6	7.6	52.0	JUN 21
JUL 1	17	74.1	5.6	74.0	83.9 68	65.0 83	90 73	83.6	4.4	84.0	49 81	60.8	8.0	61.0	JUL 1
JUL 11	20	76.0	3.8	76.0	82.1 67	68.0 83	91 67	85.3	3.9	86.0	45 83	63.3	7.5	63.5	JUL 11
JUL 21	20	79.5	3.0	79.5	84.3 68	74.9 70	91 68	86.4	2.4	86.5	55 72	69.2	7.5	69.5	JUL 21
AUG 1	20	78.7	4.9	79.5	85.4 71 M	65.4 76	95 83	86.4	4.4	87.0	51 76	67.8	8.7	67.5	AUG 1
AUG 11	19	75.3	8.2	74.0	89.7 67	60.8 68	92 67	84.6	4.6	84.0	47 68	64.2	12.0	63.0	AUG 11
AUG 21	19	71.8	7.0	69.0	83.5 70	60.2 77	92 69	81.4	5.9	79.0	47 64	59.4	8.9	57.0	AUG 21
SEP 1	19	70.2	4.8	70.0	79.0 66	61.2 64	88 67	80.5	4.7	81.0	43 64	56.3	7.7	55.0	SEP 1
SEP 11	16	63.3	7.4	62.5	76.2 81 M	49.8 78 M	86 81	74.8	6.1	74.5	37 68	47.9	7.0	46.5	SEP 11
SEP 21	16	61.8	7.7	61.5	71.9 67	50.1 77 M	83 67	73.5	6.3	74.5	37 81	48.3	8.1	47.0	SEP 21
OCT 1	14	57.9	8.5	56.5	71.7 79	45.6 82 M	78 79	68.5	7.0	70.5	35 75	46.5	9.0	47.0	OCT 1
MONTH															MONTH
MAY	13	56.6	4.1	56.0	61.9 73	49.6 77 M	85 66	75.7	5.0	76.0	28 75	38.5	5.0	39.0	MAY
JUN	15	65.1	2.7	65.0	70.7 77	61.0 76 M	87 77	82.5	3.9	83.0	38 78	43.5	3.1	43.0	JUN
JUL	18	76.7	2.9	77.0	81.2 67	70.4 83	91 68	88.2	1.9	89.0	45 83	57.4	6.6	58.0	JUL
AUG	19	75.1	5.3	74.0	84.5 67	66.1 76	95 83	87.9	3.8	88.0	47 68	56.7	7.3	55.0	AUG
SEP	13	66.8	4.2	67.0	72.6 67	61.0 77 M	88 67	81.2	4.1	81.0	37 81	46.1	5.4	46.0	SEP

RELATIVE HUMIDITY

MEAN, STANDARD DEVIATION, AND EXTREME VALUES

STATION NUMBER 101209 MC CALL SO — 1964-1983

10-DAY AND MONTHLY PERIOD MEANS / 10-DAY AND MONTHLY EXTREME DAILY VALUES

PRD. BEGINS	NO. YRS	MEAN	STD. DEV.	MEDIAN	HIGHEST AVG,YR	LOWEST AVG,YR	HIGH,YR	AVG. HIGH	STD. DEV.	MEDIAN HIGH	LOW,YR	AVG. LOW	STD. DEV.	MEDIAN LOW	PRD. BEGINS
MAY 1	11	54.2	9.6	54.0	68.8 77 M	40.6 72	100 75	84.5	12.9	88.0	14 72	28.1	8.0	27.0	MAY 1
MAY 11	16	42.6	10.1	40.0	60.7 78	22.1 73	100 66	70.2	17.7	73.5	14 73	24.9	6.1	23.5	MAY 11
MAY 21	16	47.4	12.5	45.5	70.9 64	29.3 83	93 80	73.6	13.2	74.5	13 66	25.1	7.7	25.0	MAY 21
JUN 1	17	44.0	10.5	46.0	59.7 80 M	26.0 65	99 78	74.5	21.3	84.0	9 64	22.2	6.8	25.0	JUN 1
JUN 11	17	47.9	11.0	46.0	70.9 64	32.1 66	100 79	76.9	20.9	81.0	9 71	27.9	8.2	26.0	JUN 11
JUN 21	19	42.1	10.1	41.0	61.2 69	26.1 81	100 70	72.9	20.9	76.0	5 64	23.6	9.0	23.0	JUN 21
JUL 1	17	35.3	9.5	34.0	59.3 78 M	20.0 73	100 83	59.2	20.2	56.0	6 77	20.9	7.9	21.0	JUL 1
JUL 11	20	33.6	7.1	32.5	51.2 75	24.4 66	100 76	58.1	19.3	53.0	14 79	21.9	6.0	21.0	JUL 11
JUL 21	20	29.0	7.7	28.5	43.6 70	15.8 68	100 77	49.7	18.9	43.0	8 74	17.8	6.3	18.0	JUL 21
AUG 1	20	29.8	12.0	25.5	66.5 76	16.9 69	100 76	52.1	25.0	39.0	7 78	17.4	6.6	15.0	AUG 1
AUG 11	19	34.4	14.6	31.0	62.1 76	14.9 67	100 76	58.5	27.7	54.0	8 73	20.1	8.1	20.0	AUG 11
AUG 21	19	35.8	13.7	33.0	60.7 75	15.4 69	100 83	66.7	27.1	63.0	6 74	19.3	9.2	19.0	AUG 21
SEP 1	19	33.7	8.1	32.0	56.4 78	22.8 66	100 78	57.2	22.7	48.0	13 69	19.2	5.2	18.0	SEP 1
SEP 11	16	45.3	14.6	46.0	64.6 76	16.0 79 M	100 80	79.9	23.6	84.5	8 79	24.0	9.2	23.5	SEP 11
SEP 21	16	44.3	12.0	42.5	72.4 77 M	28.3 75	100 82	76.9	20.5	77.0	11 83	23.3	8.2	23.0	SEP 21
OCT 1	14	46.6	15.8	45.0	72.3 67	21.2 79	100 81	75.2	23.2	82.0	13 79	25.4	9.0	22.5	OCT 1
MONTH															MONTH
MAY	13	47.5	8.2	46.0	61.7 78 M	33.7 73	100 75	89.6	8.1	92.0	13 66	21.8	6.2	22.0	MAY
JUN	15	44.6	6.2	43.0	61.0 80 M	34.6 73	100 79	92.1	7.1	94.0	5 64	19.0	6.1	18.0	JUN
JUL	18	32.5	6.5	33.0	41.3 70	22.4 68	100 83	69.8	20.3	62.5	6 77	15.6	5.2	17.0	JUL
AUG	19	33.6	11.0	34.0	61.0 76	18.4 69	100 83	76.5	25.4	87.0	6 74	14.5	7.0	13.0	AUG
SEP	13	39.8	8.4	39.0	54.4 77 M	26.8 79 M	100 82	89.7	13.4	94.0	8 79	16.2	5.5	15.0	SEP

Table 26—Frequencies of observed afternoon dry bulb and relative humidity values, at stations as in table 25

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1										34	80	57	148	125	159	148	114	91	45				MAY 1
MAY 11										11	56	100	89	133	156	144	89	100	67	56			MAY 11
MAY 21											27	55	100	100	118	245	118	127	73	27	9		MAY 21
JUN 1												15	92	115	108	154	131	154	131	62	31	8	JUN 1
JUN 11											8	15	69	85	138	138	123	138	169	77	38		JUN 11
JUN 21											8	23	62	38	69	108	115	162	208	100	69	38	JUN 21
JUL 1													7	13	47	87	100	167	113	227	193	47	JUL 1
JUL 11													7	7	27	20	80	167	173	213	187	120	JUL 11
JUL 21														6	30	24	30	133	152	230	242	152	JUL 21
AUG 1															20	33	67	100	147	213	233	187	AUG 1
AUG 11												7	47	20	73	40	53	113	107	173	207	160	AUG 11
AUG 21												6	36	24	85	91	152	158	121	139	103	85	AUG 21
SEP 1												13	47	73	100	120	107	193	180	87	53	27	SEP 1
SEP 11											7	80	43	152	210	145	138	152	51	22			SEP 11
SEP 21										16	8	32	104	40	176	232	208	96	24	32	32		SEP 21
OCT 1											56	144	133	111	156	278	111	11					OCT 1
OCT 11										12	99	111	235	259	210	49	25						OCT 11
OCT 21										96	164	260	247	151	82								OCT 21
MONTH																							MONTH
MAY										14	52	69	111	118	142	184	108	108	63	28	3		MAY
JUN											5	18	74	79	105	133	123	151	169	79	46	15	JUN
JUL													4	9	34	43	69	155	146	224	209	108	JUL
AUG												4	28	15	60	56	92	125	125	174	178	142	AUG
SEP										5	5	41	63	90	160	162	148	150	90	48	29	10	SEP
OCT										33	102	168	201	172	152	119	49	4					OCT

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1			68	114	91	102	159	80	80	57	45	23	23	34	34	23	23	11	34			MAY 1
MAY 11		11	89	78	100	89	133	111	67	56	78	22	22	33	44	33	22	11				MAY 11
MAY 21			100	91	136	145	82	82	100	91	27	45	9	36	9	27	9		9			MAY 21
JUN 1		8	38	92	146	185	92	85	85	85	15	46	8	15		54	23	15	8			JUN 1
JUN 11			38	92	192	154	108	100	46	31	46	23	15	23	23	38	38	31				JUN 11
JUN 21			69	169	162	115	162	85	62	23	15	15	31	8	23	38	15		8			JUN 21
JUL 1		47	187	160	113	127	140	53	53	20	27	13	13	13	20	7	7					JUL 1
JUL 11		60	173	200	93	167	127	47	47	33	13	13		7				13		7		JUL 11
JUL 21		109	224	236	164	67	85	30	6	24	6	24		6			12		6			JUL 21
AUG 1		147	240	187	173	80	27	47	20	13	13	13	20	13				7				AUG 1
AUG 11		127	247	220	73	47	60	27	27	27	13	27	13	27	13	13	20	20				AUG 11
AUG 21		115	188	91	145	73	115	61	61	30	30	18	6	12	12	12		30				AUG 21
SEP 1		47	133	120	160	187	127	40	33	27	7	20	27	13	7	7	13	27		7		SEP 1
SEP 11		7	51	109	181	145	65	101	51	72	22	36	7	36	22	36	29	14	14			SEP 11
SEP 21		24	40	120	144	136	152	112	88	48	24	16	16		24	16	24	8	8			SEP 21
OCT 1				33	89	189	167	111	56	33	22	11	44	67	44	44	56	22	11			OCT 1
OCT 11			12	25	86	111	173	136	136	49	74	12	37	25	12	37	12	37	25			OCT 11
OCT 21							55	110	178	164	82	110	68	96	41	41	14	14	27			OCT 21
MONTH																						MONTH
MAY		3	87	94	111	115	122	90	83	69	49	31	17	35	28	28	17	7	14			MAY
JUN		3	49	118	167	151	121	90	64	46	26	28	18	15	15	44	26	15	5			JUN
JUL		73	196	200	125	118	116	43	34	26	15	17	4	9	6	2	6	4	2	2		JUL
AUG		129	224	163	131	67	69	45	37	24	19	19	13	17	9	9	6	19				AUG
SEP		27	77	116	162	157	114	82	56	48	17	24	17	17	17	19	22	17	7	2		SEP
OCT			4	20	61	107	135	119	119	78	57	41	49	61	33	41	29	25	20			OCT

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101019 HELLS HALF ACRE LO 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JUL 1								19	6	45	45	116	103	206	232	200	19	6					JUL 1
JUL 11							5	5	10	31	46	51	143	179	224	214	92						JUL 11
JUL 21										9	23	42	83	176	269	287	106	5					JUL 21
AUG 1									5	15	15	60	95	161	251	256	131	10					AUG 1
AUG 11							5	11	16	22	54	81	124	188	172	220	97	11					AUG 11
AUG 21							5	31	31	46	82	92	133	159	190	154	67	10					AUG 21
SEP 1								43	71	78	64	99	170	149	199	113	14						SEP 1
MONTH																							MONTH
JUL							2	7	5	26	37	65	109	185	243	238	78	4					JUL
AUG							3	14	17	28	50	78	117	169	205	210	98	10					AUG

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101019 HELLS HALF ACRE LO 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
JUL 1				6	65	103	123	52	148	103	84	97	39	32	45	19	6	39	19		19	JUL 1
JUL 11			15	31	97	77	133	97	117	97	56	61	46	41	31	36	5	10	36		15	JUL 11
JUL 21		5	14	51	111	162	130	93	102	102	60	42	23	19	37	9	9	9	19		5	JUL 21
AUG 1			20	70	131	141	151	85	85	70	65	25	35	45	20	15	15	10	10		5	AUG 1
AUG 11			59	108	102	124	81	65	59	48	91	54	27	38	27	27	27	16	22		27	AUG 11
AUG 21		10	36	92	97	62	77	87	77	56	67	72	56	36	15	26	26	36	46		26	AUG 21
SEP 1		7	14	21	106	106	106	64	113	57	92	78	71	14	21	21	14	7	14		71	SEP 1
MONTH																						MONTH
JUL		2	11	32	93	116	129	83	120	101	65	63	35	30	37	21	7	18	25		12	JUL
AUG		3	38	90	110	109	103	79	74	59	74	50	40	40	21	22	22	21	26		19	AUG

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101019 HELLS HALF ACRE LO 1954-1970

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JUL 1								7	7	22	52	133	141	207	207	178	44						JUL 1
JUL 11										13	13	38	88	169	244	263	150	19	6				JUL 11
JUL 21									6		11	23	91	165	188	324	165	28					JUL 21
AUG 1										18	35	29	88	141	224	265	176	24					AUG 1
AUG 11							6		13	31	31	75	56	119	238	238	181	13					AUG 11
AUG 21							6	18	42	103	55	91	115	127	182	182	67	12					AUG 21
MONTH																							MONTH
JUL								2	4	11	23	59	104	178	212	261	125	17	2				JUL
AUG							4	6	18	51	40	65	87	129	214	228	141	16					AUG

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101019 HELLS HALF ACRE LO 1954-1970

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
JUL 1				15	74	119	119	59	119	111	74	44	37	59	52	44	7	15	52			JUL 1
JUL 11		6	31	44	106	125	156	131	88	69	94	25	31	25	13	25	13	6	13			JUL 11
JUL 21		6	34	68	114	210	114	102	80	63	45	51	28	34	17	11		17	6			JUL 21
AUG 1			35	82	147	171	135	100	65	59	29	18	29	24	12	41	12	24			18	AUG 1
AUG 11			56	125	194	113	88	75	56	69	50	25	13	25	19	25	6	13	31		19	AUG 11
AUG 21		12	42	115	91	109	67	85	48	36	48	48	36	24	24	42	24	24	73		48	AUG 21
MONTH																						MONTH
JUL		4	23	45	100	155	130	100	93	79	70	40	32	38	25	25	6	13	21			JUL
AUG		4	44	107	143	131	97	87	57	55	42	30	26	24	18	36	14	20	34		28	AUG

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 11									40	95	103	135	143	127	159	95	63	40					MAY 11
MAY 21									34	94	87	134	188	101	107	121	74	54	7				MAY 21
JUN 1									7	20	106	99	152	146	172	152	113	33					JUN 1
JUN 11										19	71	141	128	135	135	141	122	64	26	19			JUN 11
JUN 21									6	11	33	61	88	138	122	160	182	122	72	6			JUN 21
JUL 1												20	107	76	147	157	157	203	107	25			JUL 1
JUL 11											10	15	35	60	146	181	186	181	161	25			JUL 11
JUL 21												9	9	18	96	87	242	320	183	37			JUL 21
AUG 1													25	15	81	142	188	310	168	66	5		AUG 1
AUG 11											25	35	40	70	110	160	165	190	160	45			AUG 11
AUG 21										5	18	41	83	106	110	183	151	174	87	32	9		AUG 21
SEP 1										10	30	76	66	122	117	203	168	127	71	10			SEP 1
SEP 11									12	52	69	145	133	98	150	173	87	58	6	17			SEP 11
SEP 21									12	65	113	77	149	107	190	125	113	30	18				SEP 21
MONTH																							MONTH
JUN									4	16	68	98	121	139	141	152	141	76	35	8			JUN
JUL											3	15	49	50	128	140	197	237	151	29			JUL
AUG										2	15	26	50	65	101	163	167	223	137	47	5		AUG
SEP									7	41	69	99	113	110	151	169	125	74	33	9			SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 11		8	32	40	79	95	71	87	135	87	56	40	56	8	32	48	32	16	40		40	MAY 11
MAY 21				67	67	114	87	94	67	67	67	34	60	20	47	54	40	47	60		7	MAY 21
JUN 1				46	46	119	86	139	53	106	53	13	66	60	40	46	60	33	33			JUN 1
JUN 11				26	64	115	96	96	77	90	58	38	64	51	58	51	32	45	26		13	JUN 11
JUN 21			33	50	44	88	116	122	105	77	88	55	28	39	28	28	28	50	17		6	JUN 21
JUL 1		5	15	81	81	127	142	66	81	142	51	46	36	46	15	25	5	15	15	5		JUL 1
JUL 11			10	106	85	111	136	141	116	55	45	55	40	25	15	30	5		15	10		JUL 11
JUL 21		5	18	96	169	164	192	91	91	50	9	37	18	14	5	18	9		9	5		JUL 21
AUG 1		5	25	91	157	234	162	61	107	36	30	15	15	15	10	15	5	5	10			AUG 1
AUG 11		5	30	85	145	145	110	95	55	90	45	30	30	30	15	10	25	20	15		20	AUG 11
AUG 21		9	41	106	124	96	151	69	60	64	55	46	32	28	32	18	18	9	28		14	AUG 21
SEP 1			25	71	127	81	173	122	112	46	91	20	25	15	25	10	20	15	15		5	SEP 1
SEP 11			17	40	104	110	116	92	81	81	69	58	40	29	23	23	35	46	23		12	SEP 11
SEP 21		6	24	18	95	77	71	149	83	54	107	60	71	24	24	24	24	48	36		6	SEP 21
MONTH																						MONTH
JUN			12	41	51	107	100	119	80	90	68	37	51	49	41	41	39	43	25		6	JUN
JUL		3	15	94	114	135	158	99	96	81	34	46	31	28	11	24	7	5	13	7		JUL
AUG		7	33	94	141	156	141	75	73	63	44	31	26	24	20	15	16	11	18		11	AUG
SEP		2	22	45	110	89	123	121	93	59	89	45	45	22	24	19	26	35	24		7	SEP

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1951-1970

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 11									39	108	98	137	108	127	176	98	69	39					MAY 11
MAY 21									7	57	135	135	156	113	184	113	57	35	7				MAY 21
JUN 1										51	73	147	153	141	124	119	113	73	6				JUN 1
JUN 11										5	52	115	110	131	136	209	120	63	52	5			JUN 11
JUN 21									5	10	62	92	123	103	169	128	133	97	62	15			JUN 21
JUL 1										5	10	15	60	80	136	181	146	211	121	35			JUL 1
JUL 11												5	30	55	90	111	201	241	176	85	5		JUL 11
JUL 21												5	9	23	77	82	250	277	195	73	9		JUL 21
AUG 1												5	35	25	85	150	200	300	140	50	5	5	AUG 1
AUG 11											15	25	15	55	80	115	255	240	150	50			AUG 11
AUG 21										14	14	36	77	145	155	136	145	150	86	32	9		AUG 21
SEP 1										11	21	47	74	147	121	147	168	168	79	16			SEP 1
SEP 11									26	32	71	116	161	103	90	116	148	97	39				SEP 11
SEP 21										37	46	65	111	74	185	111	130	167	74				SEP 21
MONTH																							MONTH
JUN									2	21	62	117	128	124	144	153	123	78	41	7			JUN
JUL										2	3	8	32	52	100	123	201	244	165	65	5		JUL
AUG										5	10	23	44	77	108	134	198	227	124	44	5	2	AUG
SEP									9	24	44	75	113	115	126	128	152	143	64	7			SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1951-1970

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 11			39	49	59	118	78	69	118	88	20	20	49	39	49	49	20	39	39	10	49	MAY 11
MAY 21				43	64	85	113	99	85	78	57	28	64	43	64	35	28	57	57			MAY 21
JUN 1				40	40	90	119	85	51	96	79	51	73	34	34	51	45	51	62			JUN 1
JUN 11			5	21	94	68	115	120	120	84	52	31	52	47	26	42	42	63	16			JUN 11
JUN 21			15	41	62	138	138	118	97	51	56	46	26	36	21	36	21	41	46	5	5	JUN 21
JUL 1			20	80	136	116	126	106	80	95	45	40	35	20	15	45	5	5	20	10		JUL 1
JUL 11			35	95	156	161	141	131	80	60	40	10	15	15	15	15		10	10	10		JUL 11
JUL 21		9	32	123	232	132	155	86	55	50	36	23	18	14	5	18	9	5				JUL 21
AUG 1		10	45	100	120	180	185	105	90	15	40	15	15	15	15	15	5	10	15	5		AUG 1
AUG 11			50	115	155	185	150	100	75	25	35	5	15	10	20	5	5	5	20	5	20	AUG 11
AUG 21		18	45	123	95	114	136	68	59	45	64	45	27	27	36	14	18	18	36		9	AUG 21
SEP 1			37	79	158	121	147	132	74	42	63	5	26	37	5	16	21	21	16			SEP 1
SEP 11		6	26	110	65	129	58	77	77	103	77	39	26	26	19	13	26	45	58	6	13	SEP 11
SEP 21		9	37	139	120	111	102	93	65	28	74	46	65	19	19	19		19	28		9	SEP 21
MONTH																						MONTH
JUN			7	34	66	99	124	108	91	76	62	43	50	39	27	43	36	52	41	2	2	JUN
JUL		3	29	100	176	136	141	107	71	68	40	24	23	16	11	26	5	6	10	6		JUL
AUG		10	47	113	123	158	156	90	74	29	47	23	19	18	24	11	10	11	24	3	10	AUG
SEP		4	33	104	117	121	106	104	73	60	71	26	35	29	13	15	18	29	33	2	7	SEP

(con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS

1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1										37	37	106	122	159	180	132	111	69	32	11	5		MAY 1
MAY 11										5	26	79	100	116	153	200	126	84	89	21			MAY 11
MAY 21											24	53	53	129	167	196	144	100	62	62	10		MAY 21
JUN 1											5	11	53	105	132	211	163	142	111	63	5		JUN 1
JUN 11												25	65	95	110	195	100	155	145	85	20	5	JUN 11
JUN 21											5	5	40	76	40	141	152	187	162	111	51	30	JUN 21
JUL 1													15	5	35	131	116	201	156	186	131	25	JUL 1
JUL 11													5	5	25	50	120	210	250	145	110	80	JUL 11
JUL 21														9	18	23	37	78	215	301	256	64	JUL 21
AUG 1														10		30	60	85	170	300	225	120	AUG 1
AUG 11													10	35	30	70	70	190	140	170	175	110	AUG 11
AUG 21													14	32	73	118	132	164	145	182	82	59	AUG 21
SEP 1												10	20	40	70	130	155	210	205	105	45	10	SEP 1
SEP 11											5	42	74	95	174	153	142	158	116	32	11		SEP 11
SEP 21												37	80	101	112	213	239	149	37	16	16		SEP 21
OCT 1											18	72	145	114	102	181	223	114	30				OCT 1
OCT 11										7	40	113	232	245	172	113	73	7					OCT 11
MONTH																							MONTH
MAY										14	29	78	90	134	167	177	128	85	61	32	5		MAY
JUN											3	14	53	92	94	182	138	162	139	87	26	12	JUN
JUL													6	6	26	66	89	160	207	214	168	57	JUL
AUG													8	26	35	74	89	147	152	216	158	95	AUG
SEP											2	29	57	78	118	164	178	173	121	52	24	3	SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS

1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1		5	21	58	111	153	138	95	127	69	53	37	37	21	21	16	16		21			MAY 1
MAY 11		5	42	111	105	189	174	84	47	53	26	63	26	21	26	11		16				MAY 11
MAY 21		10	48	67	177	148	124	110	81	72	19	24	24	48	14	10	5	5	5	5	5	MAY 21
JUN 1		5	21	111	121	158	137	89	89	58	42	42	11	47	26	21	11	11				JUN 1
JUN 11		15	15	70	135	145	145	85	110	70	45	55	10	15	35	15	10	25				JUN 11
JUN 21		10	76	136	146	157	146	66	66	25	25	51	30	25	15	15	10					JUN 21
JUL 1		30	106	136	161	146	146	75	75	40	30	15	10	10	20							JUL 1
JUL 11		25	95	150	165	185	140	115	50	30		15	5	5	10	5	5					JUL 11
JUL 21		18	183	283	196	183	41	23	18	14	14	5	5		5	9		5				JUL 21
AUG 1		50	215	260	200	125	70	25	15		15	5		10			5	5				AUG 1
AUG 11		75	195	180	145	110	80	60	30	25	20	20	25	5	5	10		5	5	5		AUG 11
AUG 21		68	123	168	150	109	114	73	68	50	14	9	9	5	14		18	9				AUG 21
SEP 1		30	110	155	200	190	95	80	40	15	10	10	25	5	5	5	15	5	5			SEP 1
SEP 11			53	184	111	153	137	68	58	42	47	32	42	21	11	21	11	11				SEP 11
SEP 21		16	16	117	128	207	154	106	101	27	37	32	11	16	21		5	5				SEP 21
OCT 1		12	30	90	157	175	133	72	78	72	54	12	24	24	6	18	6	24			12	OCT 1
OCT 11			7	46	126	132	132	132	106	106	53	46	7	13	7	26	13	7	26		13	OCT 11
MONTH																						MONTH
MAY		7	37	78	133	163	145	97	85	65	32	41	29	31	20	12	7	7	9	2	2	MAY
JUN		10	37	105	134	153	143	80	88	51	37	49	17	29	26	17	10	12				JUN
JUL		24	129	193	175	172	107	70	47	28	15	11	6	5	11	5	2	2				JUL
AUG		65	176	202	165	115	89	53	39	26	16	11	11	6	6	3	8	6	2	2		AUG
SEP		16	61	152	147	183	128	85	66	28	31	24	26	14	12	9	10	7	2			SEP

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1951-1970

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1										56	56	100	133	156	122	133	89	78	44	22	11		MAY 1
MAY 11											10	100	80	150	110	250	90	140	60	10			MAY 11
MAY 21											9	64	27	145	173	200	127	127	82	36	9		MAY 21
JUN 1												28	39	128	112	196	123	145	156	56	11	6	JUN 1
JUN 11												5	48	80	138	144	122	160	170	96	37		JUN 11
JUN 21												5	41	67	92	154	154	144	174	87	51	31	JUN 21
JUL 1													5	15	25	90	130	120	220	205	150	40	JUL 1
JUL 11															20	25	65	135	210	230	185	130	JUL 11
JUL 21															9	32	27	68	186	264	295	118	JUL 21
AUG 1														15	10	25	40	120	150	330	220	90	AUG 1
AUG 11												5	5	30	20	10	55	95	180	280	215	105	AUG 11
AUG 21												5	23	32	55	82	191	145	145	155	91	77	AUG 21
SEP 1												10	5	40	45	115	170	125	215	170	85	20	SEP 1
SEP 11											5	42	47	105	153	153	111	111	168	74	21	11	SEP 11
SEP 21											5	27	75	81	118	156	183	151	70	97	38		SEP 21
OCT 1											16	70	117	109	148	148	188	172	23	8			OCT 1
OCT 11										10	20	129	248	149	158	149	99	40					OCT 11
MONTH																							MONTH
MAY										17	23	87	77	150	137	197	103	117	63	23	7		MAY
JUN												12	43	91	114	164	133	149	167	80	34	12	JUN
JUL													2	5	18	48	73	106	205	234	213	97	JUL
AUG												3	10	26	29	40	98	121	158	252	173	90	AUG
SEP											3	26	42	75	104	141	155	128	153	115	49	10	SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1951-1970

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1			22	78	89	100	111	67	178	56	56	33	44	56	44	11	33		22			MAY 1
MAY 11			10	110	90	170	150	130	50	50	40	70	20	20	40	30			20			MAY 11
MAY 21		18	36	73	127	91	127	118	118	100	18	27	45	55		27	9			9		MAY 21
JUN 1			11	67	106	151	112	106	128	39	101	56	39	11	28	17	22	6				JUN 1
JUN 11			11	90	96	165	170	96	117	64	69	32	11	16	16	11	21	5	5	5		JUN 11
JUN 21		5	51	128	209	128	128	87	61	41	20	41	41	10	15	15	15		5			JUN 21
JUL 1		20	110	190	225	130	170	35	40	30	30	5	5	5			5					JUL 1
JUL 11		55	125	185	255	165	85	55	25	25		5	5			10		5				JUL 11
JUL 21		41	259	300	173	118	45	9	32	5	5	9			5							JUL 21
AUG 1		55	190	315	190	110	40	20	25	10	5			15	10		5	5		5		AUG 1
AUG 11		70	205	300	170	110	40	30	10	10	5	5	10	5	10	5		15				AUG 11
AUG 21		64	164	195	159	109	59	91	32	50	18	5	9		14	5	14	14				AUG 21
SEP 1		20	180	210	235	105	75	85	25	10	10	15	5	10	5		5	5				SEP 1
SEP 11		11	95	153	168	163	74	47	53	32	74	26	21	26	11	5	5	26	5	5		SEP 11
SEP 21		22	86	140	145	183	172	59	48	43	16	16	22	5	16	16		5	5			SEP 21
OCT 1		8	63	109	164	133	78	148	70	55	39	39	8	16	8	31	8	23				OCT 1
OCT 11			20	79	129	139	129	129	69	59	40	69	30	30	10	30	20		20			OCT 11
MONTH																						MONTH
MAY		7	23	87	103	120	130	107	113	70	37	43	37	43	27	23	13		13	3		MAY
JUN		2	25	96	139	147	137	96	101	48	62	43	30	12	20	14	20	4	4	2		JUN
JUL		39	168	227	216	137	98	32	32	19	11	6	3	2	2	3	2	2				JUL
AUG		63	185	268	173	110	47	48	23	24	10	3	6	6	11	3	6	11		2		AUG
SEP		17	122	168	184	149	106	64	42	28	33	19	16	14	10	7	3	12	3	2		SEP

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101801 BONANZA GS 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JUN 11										32	43	43	140	237	247	194	54	11					JUN 11
JUN 21									7	28	70	35	92	77	148	246	162	120	14				JUN 21
JUL 1											17	39	83	78	156	194	256	144	28	6			JUL 1
JUL 11												15	20	41	127	259	239	244	56				JUL 11
JUL 21												14	14	41	55	129	300	364	74	9			JUL 21
AUG 1											5	10	20	30	110	150	250	335	85	5			AUG 1
AUG 11										5	10	50	65	65	106	166	261	236	35				AUG 11
AUG 21										15	15	59	54	117	137	210	220	151	24				AUG 21
SEP 1										17	17	39	84	106	140	229	285	73	11				SEP 1
SEP 11									28	28	105	105	112	119	189	119	154	42					SEP 11
SEP 21									67	76	59	84	126	134	143	210	92	8					SEP 21
MONTH																							MONTH
JUL											5	22	37	52	109	192	266	258	54	5			JUL
AUG										7	10	40	46	71	118	175	243	240	48	2			AUG
SEP									27	36	57	73	104	118	156	188	190	45	5				SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101801 BONANZA GS 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
JUN 11			11	32	54	194	118	172	75	75	54	65	43	22	54			22	11			JUN 11
JUN 21			56	120	113	113	134	92	77	92	49	14	21	21		35	21	28	14			JUN 21
JUL 1		6	100	183	200	133	100	61	17	28	17	22	33	28	28	6	17	6	6		11	JUL 1
JUL 11			96	213	173	127	91	102	36	61	25	25	20	5	10		15					JUL 11
JUL 21		14	147	263	166	115	97	78	37	18	5	9	9	5	5	18	5	5			5	JUL 21
AUG 1		30	135	235	235	115	65	50	25	15	20	5	20	10	20	5	5		5		5	AUG 1
AUG 11		10	131	191	181	131	80	45	65	20	15	30	20	10	35	10	10	5	5	5		AUG 11
AUG 21		5	122	171	185	156	102	54	68	24	24	15	5	15	15	15	10	10	5			AUG 21
SEP 1		17	101	201	229	134	84	78	39	17	11	17	22	11	6	22		11				SEP 1
SEP 11		7	168	154	77	105	119	49	35	56	49	35	35	28	49	7	14		7		7	SEP 11
SEP 21		8	42	176	160	126	84	76	84	25	42	25	42	17	17	17	17	17	17		8	SEP 21
MONTH																						MONTH
JUL		7	116	222	178	125	96	81	30	35	15	19	20	12	13	8	12	3	2		5	JUL
AUG		15	129	199	200	134	83	50	53	20	20	17	15	12	23	10	8	5	5	2	2	AUG
SEP		11	107	179	161	122	95	68	50	32	32	25	32	18	23	16	9	9	7		5	SEP

(con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101204 CASCADE RS 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1									33	74	174	207	116	165	116	74	17	25					MAY 1
MAY 11									31	47	102	189	205	110	134	118	55	8					MAY 11
MAY 21									14	29	29	121	179	171	164	157	86	50					MAY 21
JUN 1										7	61	122	95	196	182	149	142	47					JUN 1
JUN 11										12	61	55	147	147	172	196	153	49	6				JUN 11
JUN 21										6	24	72	30	138	174	150	222	90	96				JUN 21
JUL 1												16	27	93	77	192	198	247	137	5	5		JUL 1
JUL 11												5	10	31	82	184	219	265	179	26			JUL 11
JUL 21														28	28	61	196	402	252	33			JUL 21
AUG 1													11	17	55	116	193	359	210	39			AUG 1
AUG 11											5	48	32	53	70	150	219	214	182	27			AUG 11
AUG 21											5	24	72	115	129	163	196	196	67	33			AUG 21
SEP 1											21	11	90	122	96	213	239	165	43				SEP 1
SEP 11									5	11	66	115	143	143	143	192	137	33	11				SEP 11
SEP 21										18	91	67	152	212	188	170	55	42	6				SEP 21
OCT 1									6	57	108	121	146	223	191	127	19						OCT 1
OCT 11									41	117	145	234	179	200	69	14							OCT 11
OCT 21								39	94	180	188	227	219	39	16								OCT 21
MONTH																							MONTH
MAY									26	49	98	170	168	149	139	119	54	28					MAY
JUN										8	48	82	90	159	176	165	174	63	36				JUN
JUL												7	12	49	61	142	204	309	193	22	2		JUL
AUG											3	24	40	64	87	144	203	253	149	33			AUG
SEP									2	9	58	64	127	157	140	193	148	82	21				SEP
OCT								12	44	114	144	191	179	160	98	51	7						OCT

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101204 CASCADE RS 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1			17	91	74	66	149	124	74	83	116	74	25	25	17	41	8	17				MAY 1
MAY 11		8	16	39	126	102	102	126	102	94	47	55	31	31	47	24	8	16	24			MAY 11
MAY 21				43	179	121	107	129	93	93	21	21	64	29	43	7	7	14	21		7	MAY 21
JUN 1			20	41	74	142	155	101	68	88	68	7	54	61	7	61	14	20	20			JUN 1
JUN 11		6	6	43	110	86	129	123	98	86	67	31	49	37	25	31	37	37				JUN 11
JUN 21		6	30	54	132	192	120	84	102	84	24	30	36	6	36	12	12	30	12			JUN 21
JUL 1		5	38	121	159	220	148	93	33	55	38	49	11	5	5		5	11				JUL 1
JUL 11			41	112	219	199	168	112	36	61	5	5	20	10		5	5					JUL 11
JUL 21		5	75	206	238	210	98	65	28	28	28		5	5		5	5					JUL 21
AUG 1			99	227	199	221	110	39	33	17	11	11	6	6		6	6	11				AUG 1
AUG 11		5	70	230	176	112	128	70	43	32	27	16	11	11	16	11		21	11	5	5	AUG 11
AUG 21		5	77	124	187	129	120	77	77	48	48	48	19	5	5	10	10	10	5			AUG 21
SEP 1		11	37	133	186	181	186	85	53	27	16	16	21		5	5	11	21	5			SEP 1
SEP 11		5	33	88	126	132	82	110	88	71	66	66	27	33	16	5	11	11	27			SEP 11
SEP 21		6	12	48	91	176	133	145	79	103	48	36	24	18	18	18	18	18	6			SEP 21
OCT 1		6	13	51	89	134	172	166	96	32	70	51	25	19	25		6	38	6			OCT 1
OCT 11				14	41	69	138	152	97	138	97	48	69	14	34	41	28		14		7	OCT 11
OCT 21		8			31	39	63	39	78	156	164	55	78	70	94	31	31	16	31		16	OCT 21
MONTH																						MONTH
MAY		3	10	57	129	98	119	126	90	90	59	49	41	28	36	23	8	15	15		3	MAY
JUN		4	19	46	107	140	134	103	90	86	52	23	46	33	23	33	21	29	10			JUN
JUL		3	52	149	208	209	137	90	32	47	24	17	12	7	2	3	5	3				JUL
AUG		3	81	191	187	153	120	62	52	33	29	26	12	7	7	9	5	14	5	2	2	AUG
SEP		7	28	92	136	163	135	112	73	65	43	39	24	17	13	9	13	17	13			SEP
OCT		5	5	23	56	84	128	123	91	105	107	51	56	33	49	23	21	19	16		7	OCT

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101803 CHALLIS RS 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1									13	93	120	93	80	187	107	107	107	53	40				MAY 1
MAY 11										23	57	57	148	148	159	216	136	57					MAY 11
MAY 21										8	34	110	136	161	161	153	161	59	17				MAY 21
JUN 1										6	12	43	149	155	149	161	168	118	31	6			JUN 1
JUN 11											12	36	90	157	151	211	217	102	24				JUN 11
JUN 21											17	34	67	84	124	124	169	169	152	62			JUN 21
JUL 1												5	42	37	63	164	122	307	196	58	5		JUL 1
JUL 11													10	25	15	86	188	289	259	122	5		JUL 11
JUL 21													5	9	28	37	156	271	339	151	5		JUL 21
AUG 1												5	5	10	55	65	131	286	337	106			AUG 1
AUG 11												20	40	55	65	90	175	225	240	90			AUG 11
AUG 21												18	27	78	105	160	192	224	146	41	9		AUG 21
SEP 1												15	40	95	151	176	231	196	90	5			SEP 1
SEP 11									5	25	41	107	132	122	142	168	193	61	5				SEP 11
SEP 21									5	26	47	52	145	150	155	249	114	52	5				SEP 21
OCT 1										13	109	128	71	186	186	179	109	19					OCT 1
OCT 11									16	70	85	186	233	171	93	109	39						OCT 11
OCT 21						24	12	24	24	96	157	241	145	217	60								OCT 21
MONTH																							MONTH
MAY									4	36	64	89	125	164	146	160	139	57	18				MAY
JUN										2	14	38	101	131	141	164	184	131	71	24			JUN
JUL												2	18	23	35	93	156	288	268	113	5		JUL
AUG												15	24	49	76	107	167	244	238	78	3		AUG
SEP									3	17	29	58	105	122	149	197	180	104	34	2			SEP
OCT						5	3	5	11	52	111	174	144	188	125	114	60	8					OCT

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101803 CHALLIS RS 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1		27	120	213	200	120	67	40	27	13	67	27	27	13	40							MAY 1
MAY 11		23	102	341	102	159	114	57	45	11	11	23	11									MAY 11
MAY 21			76	237	153	144	76	59	76	17	25	51		25	17		17	17	8			MAY 21
JUN 1		19	68	230	124	149	106	68	25	68	43	19	12	25	19	6		19				JUN 1
JUN 11		6	78	114	229	199	133	60	42	30	12	18	24	24		12		6	12			JUN 11
JUN 21		39	191	180	157	101	79	45	39	22	39	34	22	17	6	6	11	6	6			JUN 21
JUL 1		69	180	175	164	164	53	53	48	26	37		5		11	11			5			JUL 1
JUL 11		76	234	264	107	117	51	20	30	30	41	10	10	10								JUL 11
JUL 21		46	275	239	183	73	46	64	28	14	14		9			5		5				JUL 21
AUG 1		106	221	261	111	70	70	40	45	20	10	15		10	5		10	5				AUG 1
AUG 11		55	205	220	105	120	60	55	45	25	35	25	20	5	5	10		10				AUG 11
AUG 21		37	174	237	169	132	78	50	46	27	14	18	5	9	5							AUG 21
SEP 1		30	171	307	176	126	50	25	60	15	15		10	10		5						SEP 1
SEP 11		10	112	173	188	117	86	96	71	36	25	15	15	30	10	5	5	5				SEP 11
SEP 21			67	181	228	181	119	57	21	52	26	21	26		16		5					SEP 21
OCT 1		26	115	250	186	154	64	96	26	13	26	13	13	13				6				OCT 1
OCT 11		16	70	116	202	171	147	101	93	16	16	16	8	23			8					OCT 11
OCT 21		12		120	145	193	169	72	84	72	24	24	24	12	12	12	12	12				OCT 21
MONTH																						MONTH
MAY		14	96	263	149	142	85	53	53	14	32	36	11	14	18		7	7	4			MAY
JUN		22	115	174	170	149	105	57	36	40	32	24	20	22	8	8	4	10	6			JUN
JUL		63	232	227	152	116	50	46	35	23	30	3	8	3	3	5		2	2			JUL
AUG		65	199	239	129	108	70	49	45	24	19	19	8	8	5	3	3	5				AUG
SEP		14	117	221	197	141	85	59	51	34	22	12	17	14	8	3	3	2				SEP
OCT		19	73	174	182	168	117	92	63	27	22	16	14	16	3	3	5	5				OCT

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101303 INDIANOLA RS 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1									6	47	88	112	165	224	124	147	82	6					MAY 1
MAY 11										17	78	94	117	128	167	161	128	72	33	6			MAY 11
MAY 21										21	21	94	126	178	105	188	152	99	16				MAY 21
JUN 1											5	42	111	95	63	179	200	205	89	11			JUN 1
JUN 11											5	47	74	100	179	147	153	179	58	42	16		JUN 11
JUN 21											5	15	51	61	111	106	146	202	182	101	20		JUN 21
JUL 1												16	31	42	42	57	172	151	245	198	47		JUL 1
JUL 11												5	5	25	15	46	102	208	239	249	96	10	JUL 11
JUL 21														5	9	37	41	146	279	356	123	5	JUL 21
AUG 1														10	20	31	71	189	276	286	112	5	AUG 1
AUG 11											5		25	60	45	50	105	160	245	185	120		AUG 11
AUG 21											5	5	18	83	78	115	138	197	206	124	32		AUG 21
SEP 1												10	50	70	75	156	141	296	156	40	5		SEP 1
SEP 11										10	31	62	128	159	123	128	164	118	72	5			SEP 11
SEP 21										10	30	81	96	162	162	213	147	76	20				SEP 21
OCT 1										6	63	160	120	189	137	194	126	6					OCT 1
OCT 11									25	34	126	227	218	160	134	50	25						OCT 11
OCT 21								25	50	58	233	183	283	117	42	8							OCT 21
MONTH																							MONTH
MAY									2	28	61	100	135	176	131	166	122	61	17	2			MAY
JUN											5	35	78	85	118	144	166	196	111	52	12		JUN
JUL												7	12	23	21	46	102	168	255	271	90	5	JUL
AUG											3	2	15	52	49	67	106	182	241	195	86	2	AUG
SEP										7	20	51	91	130	120	166	151	164	83	15	2		SEP
OCT								7	22	29	130	186	196	159	109	99	60	2					OCT

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101303 INDIANOLA RS 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1			29	88	124	153	106	100	88	82	71	35	29	24	18	18	6	18	12			MAY 1
MAY 11		22	83	83	144	156	111	89	89	39	50	44	22	22	22			17			6	MAY 11
MAY 21		5	52	94	131	131	183	89	73	52	16	31	31	21	31	5	5	21	21		5	MAY 21
JUN 1		5	47	142	184	132	95	100	74	26	47	32	32	16	16		26	21	5			JUN 1
JUN 11		11	47	116	142	126	111	95	95	79	16	32	37	21	26	21	11	5	5		5	JUN 11
JUN 21		10	66	146	197	167	106	56	61	40	56	25	20	20	10	10	5	5				JUN 21
JUL 1		42	156	125	188	130	99	57	57	31	10	10	21	10	16	5	10	10	16	5		JUL 1
JUL 11		56	142	218	188	112	107	36	61	25	10	15	5	5	5			10	5			JUL 11
JUL 21		68	210	219	183	119	64	59	37	14	5	9	5							9		JUL 21
AUG 1		82	224	199	122	122	66	71	31	20	15	20	10			10		5				AUG 1
AUG 11		55	175	175	130	110	75	60	35	60	10	10	35	5	15	5	10	10	5	15	5	AUG 11
AUG 21		37	119	128	147	151	119	50	50	46	60	23	14	18		5	14	8		9		AUG 21
SEP 1		15	95	166	191	186	85	55	70	20	20	30	25	10	15	5	5	5				SEP 1
SEP 11		10	31	164	108	108	128	82	103	67	51	36	21	21	21	10	26	10	5			SEP 11
SEP 21		10	41	61	132	173	117	122	122	56	41	15	36	25	10	15	10	5	5		5	SEP 21
OCT 1			34	126	114	183	137	120	91	51	40	17	17	17	29		11	6	6			OCT 1
OCT 11			17	42	67	134	126	126	126	92	42	42	67	34	17	8	25	17	8		8	OCT 11
OCT 21					58	50	175	117	117	150	100	58	50	42	17	17	8		17		25	OCT 21
MONTH																						MONTH
MAY		9	55	89	133	146	135	92	83	57	44	37	28	22	24	7	4	18	11		4	MAY
JUN		9	54	135	175	142	104	83	76	48	40	29	29	19	17	10	14	10	3		2	JUN
JUL		56	171	189	186	120	89	51	51	23	8	12	10	5	7	2	3	7	7	5		JUL
AUG		57	171	166	134	129	88	60	39	42	29	18	20	8	5	7	8	8	2	8	2	AUG
SEP		12	56	130	144	156	110	86	98	47	37	27	27	19	15	10	14	7	3		2	SEP
OCT			19	65	85	130	145	121	109	92	58	36	41	29	22	7	14	7	10		10	OCT

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101206 KRASSEL RS 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1									15	74	147	44	147	221	118	132	103						MAY 1
MAY 11									11	57	34	102	102	102	182	159	114	68	68				MAY 11
MAY 21										52	72	113	72	186	93	124	155	113	21				MAY 21
JUN 1										16	8	64	120	96	160	136	176	152	40	32			JUN 1
JUN 11											15	80	95	73	153	197	117	182	80	7			JUN 11
JUN 21										6	12	36	65	89	95	95	213	178	124	71	18		JUN 21
JUL 1											6	11	22	50	50	94	138	215	182	166	61	6	JUL 1
JUL 11												15	5	15	30	76	107	254	198	234	61	5	JUL 11
JUL 21														18	14	18	73	169	279	324	105		JUL 21
AUG 1													5	10	15	31	97	179	276	270	112	5	AUG 1
AUG 11												30	30	36	46	86	76	162	228	244	61		AUG 11
AUG 21												23	37	51	97	120	143	189	180	124	23	14	AUG 21
SEP 1												27	48	53	90	128	176	255	176	43	5		SEP 1
SEP 11										18	29	117	111	111	111	123	170	146	58	6			SEP 11
SEP 21										23	69	38	160	191	137	214	76	84	8				SEP 21
OCT 1										36	108	133	48	241	145	229	60						OCT 1
MONTH																							MONTH
MAY									8	59	79	91	103	166	130	138	126	67	32				MAY
JUN										7	12	58	90	86	132	139	172	172	86	39	7		JUN
JUL											2	8	8	27	30	60	104	211	223	246	77	3	JUL
AUG												18	25	33	54	80	107	177	226	210	64	7	AUG
SEP										12	29	61	100	110	110	149	147	171	90	18	2		SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101206 KRASSEL RS 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1			29	103	147	74	103	59	147	74	74	74	29	15	15	29		15	15			MAY 1
MAY 11		23	114	159	193	91	45	91	91	57		11	23	11	23		23	23	23			MAY 11
MAY 21			72	186	165	113	82	52	82	41	10	62	62	10	21			10	21	10		MAY 21
JUN 1			120	168	136	144	48	88	88	32	16	24	32	16	8	16	16	16	24		8	JUN 1
JUN 11		7	29	139	168	182	102	109	29	36	36	36	15	22	15	15	15	44				JUN 11
JUN 21		12	83	189	172	124	89	83	41	41	41	30	6	6	12	12	6	24	18		12	JUN 21
JUL 1		44	160	287	188	94	22	44	50	11	33	11	6	6	6		17		6		17	JUL 1
JUL 11		25	269	264	183	86	66	20	20	20	5		5		10		15	10				JUL 11
JUL 21		50	333	228	137	142	23	23	27	5		9		5		5		5	9			JUL 21
AUG 1		77	321	276	122	66	46	31	10	15	5	10				5	5	5	5			AUG 1
AUG 11		81	289	188	91	96	66	25	36	15	20	25		15		30	5	5	5		5	AUG 11
AUG 21		83	147	180	157	106	101	65	37	18	18	14	23	9	5	9	5	14	5		5	AUG 21
SEP 1		27	138	255	239	74	85	43	32	21	27		5	5	11	5	16	5	11			SEP 1
SEP 11		6	117	158	135	111	88	82	47	47	18	23	18		29	53	18	29	18		6	SEP 11
SEP 21		8	76	92	137	53	145	168	69	115	46	8	15	8	8	15		23	15			SEP 21
OCT 1		12	108	169	60	133	181	48	12	48	60	24	12		24	24	12	12	60			OCT 1
MONTH																						MONTH
MAY		8	75	154	170	95	75	67	103	55	24	47	40	12	20	8	8	16	20	4		MAY
JUN		7	77	167	160	148	81	93	51	37	32	30	16	14	12	14	12	28	14		7	JUN
JUL		40	260	258	168	109	37	28	32	12	12	7	3	3	5	2	10	5	5		5	JUL
AUG		80	249	213	125	90	72	41	28	16	15	16	8	8	2	15	5	8	5		3	AUG
SEP		14	114	178	176	82	102	90	47	55	29	10	12	4	16	24	12	18	14		2	SEP

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101207 LANDMARK RS 1964-1981

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
JUN 21									10	20	51	61	102	153	163	214	163	61					JUN 21
JUL 1										6	19	13	64	122	179	269	218	90	19				JUL 1
JUL 11											17	6	22	67	197	247	242	169	34				JUL 11
JUL 21												15	10	35	66	222	354	278	20				JUL 21
AUG 1											6	11	34	45	157	185	292	247	22				AUG 1
AUG 11										17	45	34	63	91	136	210	170	210	23				AUG 11
AUG 21										15	66	51	117	107	173	157	188	112	15				AUG 21
SEP 1										40	28	68	136	102	169	271	130	56					SEP 1
SEP 11							6	11	17	86	121	132	109	144	161	138	63	11					SEP 11
SEP 21								15	74	81	67	119	156	163	119	156	37	15					SEP 21
OCT 1								11	44	88	154	143	110	132	143	143	33						OCT 1
MONTH																							MONTH
JUL										2	11	11	30	71	143	244	276	186	24				JUL
AUG										11	40	33	73	82	156	183	216	187	20				AUG
SEP							2	8	27	68	72	105	132	134	152	191	80	29					SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101207 LANDMARK RS 1964-1981

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
JUN 21			20	143	133	194	102	102	92	82	31	10	20		20	41			10			JUN 21
JUL 1			26	167	192	179	167	77	71	38	19	19	13		6	6	6	13				JUL 1
JUL 11			51	185	169	202	140	107	39	22	22	11	22			11	11	6				JUL 11
JUL 21		10	96	263	217	177	86	56	51	15	10	5				5	5		5			JUL 21
AUG 1		34	112	275	185	163	90	17	34	11	11	6	11	22	6	6	6	11				AUG 1
AUG 11		11	102	205	136	136	97	85	34	40	23	11	28	11	23	11	11	28	6			AUG 11
AUG 21			46	183	162	168	107	81	71	41	25	15	30	5	10	15	5	15	20			AUG 21
SEP 1		6	56	153	260	153	62	119	56	6	6	23	17	6	17	11	6	28	17			SEP 1
SEP 11			69	109	80	144	109	52	92	34	34	23	40	23	57	40	29	52	11			SEP 11
SEP 21			22	119	170	119	111	133	74	30	7	22	44	22	22	30	7	22	30		15	SEP 21
OCT 1			99	110	154	88	55	77	88	33	66	33	66	33	33	11	11		44			OCT 1
MONTH																						MONTH
JUL		4	60	209	194	186	128	79	53	24	17	11	11		2	8	8	6	2			JUL
AUG		15	85	220	162	156	98	62	47	31	20	11	24	13	13	11	7	18	9			AUG
SEP		2	51	128	171	140	93	99	74	23	16	23	33	16	33	27	14	35	19		4	SEP

(con.)

Table 26 (Con.)

DRY BULB TEMPERATURE

PERC.NTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101805 LITTLE CREEK GS 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 21										44	89	100	133	178	111	156	100	67	22				MAY 21
JUN 1										6	25	38	95	108	139	158	209	146	57	19			JUN 1
JUN 11										6	6	68	68	136	136	191	185	99	68	31	6		JUN 11
JUN 21											18	24	53	47	124	142	201	160	154	59	18		JUN 21
JUL 1												16	26	47	58	105	141	215	220	147	26		JUL 1
JUL 11											5		10	20	20	71	117	289	228	203	36		JUL 11
JUL 21														5	5	50	96	161	330	307	41		JUL 21
AUG 1													10	10	30	71	131	177	237	283	51		AUG 1
AUG 11												10	51	66	45	61	141	222	212	162	30		AUG 11
AUG 21											5	24	33	53	124	163	148	177	148	120	5		AUG 21
SEP 1												48	37	85	106	138	222	238	111	16			SEP 1
SEP 11									6	17	57	103	98	144	149	126	172	109	17				SEP 11
SEP 21										16	56	40	152	176	168	184	128	40	40				SEP 21
MONTH																							MONTH
JUN										4	16	43	72	96	133	164	198	135	94	37	8		JUN
JUL											2	5	12	23	28	74	117	219	262	223	35		JUL
AUG											2	12	31	43	68	99	140	192	198	187	28		AUG
SEP									2	10	35	66	88	129	137	145	180	141	59	6			SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101805 LITTLE CREEK GS 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 21			22	144	111	78	122	56	56	78	44	78	44	44	44	22	11	22	11		11	MAY 21
JUN 1		13	38	152	190	139	95	82	70	63	44	32	25	13		6	25	13				JUN 1
JUN 11		25	74	130	167	93	99	142	56	49	37	31	25	31	12	19					12	JUN 11
JUN 21		12	142	136	154	166	112	89	53	41	12	24	12	6	12		18	12				JUN 21
JUL 1		31	225	183	173	120	84	26	21	16	10	31	10	21	10	21	5	5			5	JUL 1
JUL 11		10	208	269	152	162	86	25	15	10		10	5	20	10	10	5					JUL 11
JUL 21		37	317	234	151	83	73	55	9	9	14	9			5			5				JUL 21
AUG 1		106	273	192	126	106	45	30	35	10	25	10	5	10	10			10		5		AUG 1
AUG 11		131	177	187	81	136	81	25	35	40	5	25	20	10	25		5		5		10	AUG 11
AUG 21		62	139	225	115	115	86	38	53	62	24	24	10	5	14	10	10	5	5			AUG 21
SEP 1		21	95	180	275	164	74	48	16	16	21		16	26	11	21	5		11			SEP 1
SEP 11			69	178	138	98	98	75	46	75	34	29	57	23	6	34	11	23	6			SEP 11
SEP 21			24	136	160	144	152	104	72	40	24	24	32	24		32		16	8		8	SEP 21
MONTH																						MONTH
JUN		16	86	139	170	133	102	104	59	51	31	29	20	16	8	8	14	8			4	JUN
JUL		26	252	229	158	120	81	36	15	12	8	17	5	13	8	10	3	3			2	JUL
AUG		99	195	202	107	119	71	31	41	38	18	20	12	8	17	3	5	5	3	2	3	AUG
SEP		8	68	168	197	135	102	72	41	43	27	16	35	25	6	29	6	12	8		2	SEP

(con.)

DRY BULB TEMPERATURE

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101209 MC CALL SO 1964-1983

TEMPERATURE VALUES

PRD. BEGINS	BELOW 0	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100 AND ABOVE	PRD. BEGINS
MAY 1							9	36	36	180	153	135	135	171	99	36	9						MAY 1
MAY 11									19	83	89	217	159	178	115	83	51	6					MAY 11
MAY 21									17	68	73	192	164	141	107	119	90	23	6				MAY 21
JUN 1									6	24	65	76	153	153	171	212	100	24	18				JUN 1
JUN 11										40	62	147	119	141	186	164	107	34					JUN 11
JUN 21										16	38	71	93	120	158	197	137	120	49				JUN 21
JUL 1											6	39	45	73	96	208	247	169	112	6			JUL 1
JUL 11											5	5	21	46	113	191	294	186	124	15			JUL 11
JUL 21													14	19	28	135	223	381	191	9			JUL 21
AUG 1												15	5	41	67	103	227	330	186	21	5		AUG 1
AUG 11											22	65	16	65	76	141	211	200	168	38			AUG 11
AUG 21											10	44	99	113	123	177	187	143	84	20			AUG 21
SEP 1										11	11	38	65	152	120	217	245	120	22				SEP 1
SEP 11									6	25	107	119	138	138	107	176	126	50	6				SEP 11
SEP 21									19	51	77	103	115	192	179	147	90	26					SEP 21
OCT 1									26	113	99	132	139	166	139	146	40						OCT 1
MONTH																							MONTH
MAY							2	9	22	101	99	187	155	162	108	85	56	11	2				MAY
JUN									2	26	55	98	121	138	172	191	115	60	23				JUN
JUL											3	14	26	44	77	175	254	252	145	10			JUL
AUG											10	41	41	74	89	141	208	223	144	26	2		AUG
SEP									8	28	62	84	104	160	134	182	158	68	10				SEP

RELATIVE HUMIDITY

PERCENTAGE FREQUENCY DISTRIBUTION OF DAILY VALUES
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101209 MC CALL SO 1964-1983

HUMIDITY VALUES

PRD. BEGINS	0 TO 4	5 TO 9	10 TO 14	15 TO 19	20 TO 24	25 TO 29	30 TO 34	35 TO 39	40 TO 44	45 TO 49	50 TO 54	55 TO 59	60 TO 64	65 TO 69	70 TO 74	75 TO 79	80 TO 84	85 TO 89	90 TO 94	95 TO 99	100	PRD. BEGINS
MAY 1			9	18		99	126	126	54	108	54	63	54	54	81	27	36	27	36	9	18	MAY 1
MAY 11			13	38	64	127	172	134	76	96	64	51	32	19	32	25	13	25	13		6	MAY 11
MAY 21			6	11	96	119	147	68	62	79	56	73	73	45	34	34	45	17	34			MAY 21
JUN 1		6	18	18	71	159	124	147	94	82	12	76	24	29		47	18	35	35	6		JUN 1
JUN 11		6		11	45	130	153	90	96	68	107	51	11	45	51	28	34	17	28	6	23	JUN 11
JUN 21		5	11	27	109	153	98	120	115	82	87	55	27	16	5	22	16	11	27		11	JUN 21
JUL 1		6	5	79	129	191	135	129	112	73	45	17	22	11	11		6	17	6		6	JUL 1
JUL 11			5	98	155	175	206	124	88	41	36	36	5	5		5	5	10			5	JUL 11
JUL 21		5	70	163	153	195	121	121	84	28	33	5	5		5		5				5	JUL 21
AUG 1		5	67	211	170	175	129	93	21	21	31	21	5	5		10	5	15	5		10	AUG 1
AUG 11		11	86	141	114	178	124	76	49	32	43	32	11	16	16	11	11	27	11		11	AUG 11
AUG 21		10	59	133	153	123	108	64	69	54	64	34	39	20	15	10		15	5		25	AUG 21
SEP 1			33	60	141	239	223	92	49	38	27	22	11		16	11	22		11		5	SEP 1
SEP 11		6	25	75	63	132	145	88	57	75	38	44	50	31	25	13	31	31	25		44	SEP 11
SEP 21			19	19	103	128	141	90	83	122	64	38	38	26	32	6	19	19	13		38	SEP 21
OCT 1			20	20	132	119	139	86	73	66	13	60	33	46	46	13	40	20	46		26	OCT 1
MONTH																						MONTH
MAY			9	22	61	117	151	106	65	92	58	63	54	38	45	29	31	22	27	2	7	MAY
JUN		6	9	19	75	147	125	119	102	77	70	60	21	30	19	32	23	21	30	4	11	JUN
JUL		3	29	116	147	187	153	124	94	46	37	19	12	5	5	2	5	9	2		5	JUL
AUG		9	70	162	146	158	120	77	46	36	46	29	19	14	10	10	5	19	7		15	AUG
SEP		2	26	52	104	170	172	90	62	76	42	34	32	18	24	10	24	16	16		28	SEP

Table 27—Windspeed (miles/hour) averages and frequencies, by wind direction, during fire season. Based on available years of record during 1964-83, at early or mid-afternoon observation time (see table 25 caption)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

MONTH MAY

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	4	15	8	29	6	22	2	7					20	73	6.5
E			4	15	1	4							5	18	5.8
SE			1	4									1	4	7.0
S			9	33									9	33	6.3
SW	17	62	91	332	33	120	9	33	2	7	3	11	155	566	7.1
W	3	11	7	26	7	26	1	4					18	66	7.4
NW			1	4	1	4							2	7	7.5
N	5	18	31	113	23	84	2	7	2	7			63	230	7.7
CLM	1	4											1	4	0.0
TOT	30	109	152	555	71	259	14	51	4	15	3	11	274		7.2

MONTH JUN

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	7	19	14	38	13	35	1	3	1	3			36	98	7.3
E	1	3	8	22	2	5	1	3					12	33	6.9
SE	2	5	3	8									5	14	3.6
S	4	11	8	22	7	19	1	3					20	54	6.9
SW	36	98	107	290	37	100	11	30	3	8	4	11	198	537	6.8
W	2	5	5	14	4	11							11	30	6.8
NW	1	3	4	11									5	14	5.2
N	6	16	48	130	21	57	5	14			1	3	81	220	7.0
CLM	1	3											1	3	0.0
TOT	60	163	197	534	84	228	19	51	4	11	5	14	369		6.8

MONTH JUL

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	2	4	20	43	13	28	1	2					36	77	7.2
E	1	2	8	17	2	4							11	24	6.5
SE					2	4							2	4	10.5
S	2	4	16	34	2	4	3	6	2	4			25	54	8.1
SW	24	52	166	357	61	131	18	39	1	2			270	581	6.7
W			9	19	6	13	2	4					17	37	8.1
NW	1	2	1	2	4	9							6	13	7.2
N	4	9	43	92	41	88	10	22					98	211	8.2
CLM															
TOT	34	73	263	566	131	282	34	73	3	6			465		7.2

MONTH AUG

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	3	7	10	22	10	22	4	9					27	59	8.0
E			5	11	4	9	2	4					11	24	8.6
SE			1	2	1	2							2	4	7.0
S	2	4	12	26	10	22	6	13	1	2			31	67	8.6
SW	18	39	144	312	69	150	20	43	5	11	3	7	259	562	7.7
W	6	13	9	20	8	17	1	2	1	2			25	54	7.3
NW			5	11	1	2	2	4					8	17	8.4
N	7	15	39	85	46	100	6	13					98	213	7.8
CLM															
TOT	36	78	225	488	149	323	41	89	7	15	3	7	461		7.8

MONTH SEP

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	3	8	16	41	8	21	3	8	1	3			31	79	7.7
E			2	5	2	5	2	5					6	15	10.3
SE					1	3							1	3	12.0
S	6	15	13	33	4	10	1	3	1	3			25	64	6.8
SW	55	141	127	326	23	59	5	13	1	3	1	3	212	544	5.4
W	9	23	20	51	2	5							31	79	4.6
NW	6	15	3	8									9	23	3.4
N	5	13	35	90	27	69	4	10			1	3	72	185	7.6
CLM	3	8											3	8	0.0
TOT	87	223	216	554	67	172	15	38	3	8	2	5	390		6.0

MONTH OCT

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	8	35	3	13	1	4							12	52	2.4
E	2	9	3	13									5	22	4.0
SE			1	4									1	4	4.0
S	3	13	4	17	1	4							8	35	4.5
SW	74	323	28	122	7	31	2	9					111	485	3.6
W	8	35	4	17	1	4							13	57	3.6
NW	4	[illegible]	1	4	2	9							7	31	5.3
N	14	6	18	79	3	13							35	153	4.6
CLM	37	162											37	162	0.0
TOT	150	655	62	271	15	66	2	9					229		3.2

STATION NUMBER 101010 DIXIE RS 1951-1967

MONTH JUL

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	16	31	16	31	13	25							45	88	5.3
E	6	12	10	19									16	31	4.0
SE	3	6	5	10									8	16	4.3
S	8	16	15	29	10	19	1	2					34	66	6.1
SW	36	70	63	123	19	37	3	6					121	236	5.2
W	31	60	63	123	19	37	1	2					114	222	5.2
NW	23	45	34	66	13	25							70	136	4.9
N	22	43	38	74	8	16	1	2					69	135	4.8
CLM	36	70											36	70	0.0
TOT	181	353	244	476	82	160	6	12					513		4.8

MONTH AUG

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	23	45	25	48	6	12			1	2			55	107	4.7
E	4	8	11	21	2	4	1	2					18	35	5.7
SE	7	14	6	12	1	2							14	27	3.7
S	15	29	17	33	3	6	2	4			1	2	38	74	5.7
SW	40	78	53	103	17	33	2	4	1	2			113	219	5.0
W	41	79	62	120	19	37	1	2					123	238	5.0
NW	24	47	33	64	14	27	1	2	1	2			73	141	5.4
N	17	33	33	64	8	16							58	112	4.9
CLM	24	47											24	47	0.0
TOT	195	378	240	465	70	136	7	14	3	6	1	2	516		4.8

MONTH SEP

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	14	40	10	29	3	9							27	78	3.9
E	6	17	5	14	1	3							12	34	3.9
SE	4	11	10	29	2	6							16	46	4.4
S	5	14	12	34	5	14							22	63	5.5
SW	37	106	53	152	13	37	1	3					104	299	4.7
W	43	124	36	103	9	26							88	253	4.1
NW	14	40	15	43	4	11							33	95	4.3
N	7	20	11	32	4	11	1	3					23	66	5.5
CLM	23	66											23	66	0.0
TOT	153	440	152	437	41	118	2	6					348		4.2

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1964-1983

MONTH JUN

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	24	53			1	2	1	2					26	58	1.2
E	8	18	4	9	1	2							13	29	2.9
SE	3	7	3	7	1	2							7	15	3.4
S	9	20	5	11	1	2							15	33	3.8
SW	39	86	14	31	5	11	2	4	1	2			61	135	4.0
W	41	91	29	64	20	44	8	18	1	2			99	219	5.6
NW	66	146	78	173	41	91	5	11					190	420	5.4
N	8	18	8	18	3	7							19	42	4.3
CLM	22	49											22	49	0.0
TOT	220	487	141	312	73	162	16	35	2	4			452		4.6

MONTH JUL

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	23	38	2	3			1	2					26	43	1.7
E	6	10	8	13	3	5							17	28	4.8
SE	4	7	3	5	4	7							11	18	5.3
S	11	18	20	33	8	13							39	64	5.2
SW	22	36	30	49	12	20	2	3					66	108	5.3
W	27	44	53	87	33	54	2	3					115	189	6.0
NW	60	98	141	231	71	116	4	7					276	452	5.9
N	8	13	18	30	8	13							34	56	5.6
CLM	26	43											26	43	0.0
TOT	187	307	275	451	139	228	9	15					610		5.3

MONTH AUG

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	12	20	7	11	1	2							20	33	2.5
E	9	15	6	10	3	5							18	30	4.3
SE	3	5	13	21	5	8	2	3					23	38	6.8
S	14	23	21	34	9	15	1	2					45	74	5.3
SW	14	23	31	51	7	11	1	2					53	87	5.4
W	35	57	67	110	40	66	2	3					144	236	5.8
NW	60	98	111	182	75	123	7	11	1	2			254	416	6.1
N	12	20	8	13	12	20							32	52	5.5
CLM	21	34											21	34	0.0
TOT	180	295	264	433	152	249	13	21	1	2			610		5.6

MONTH SEP

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	17	34	7	14									24	48	2.0
E	9	18	7	14	2	4							18	36	3.9
SE	6	12	3	6	5	10	3	6					17	34	7.1
S	16	32	16	32	5	10	1	2					38	75	4.7
SW	27	53	26	51	12	24							65	129	4.5
W	22	44	46	91	17	34	1	2					86	170	5.4
NW	63	125	81	160	40	79	7	14	2	4			193	382	5.7
N	12	24	15	30	4	8			1	2			32	63	4.8
CLM	32	63											32	63	0.0
TOT	204	404	201	398	85	168	12	24	3	6			505		4.8

STATION NUMBER 101032 RED RIVER RS 1951-1970

MONTH JUN

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	9	18	8	16			1	2					18	35	4.1
E	4	8	10	20	1	2							15	29	4.6
SE	4	8	3	6	1	2							8	16	3.5
S	3	6	4	8	1	2							8	16	4.8
SW	10	20	3	6	4	8	2	4	1	2			20	39	5.9
W	28	55	34	66	24	47	4	8					90	176	5.8
NW	92	180	112	219	51	100	5	10					260	508	5.3
N	19	37	41	80	22	43	2	4					84	164	5.7
CLM	9	18											9	18	0.0
TOT	178	348	215	420	104	203	14	27	1	2			512		5.3

MONTH JUL

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	4	7	9	15	2	3	1	2	1	2			17	28	6.4
E	3	5	8	13	4	7							15	25	5.5
SE	4	7	4	7	4	7							12	20	5.2
S	4	7	9	15	3	5							16	26	5.3
SW	8	13	10	16	7	12	1	2					26	43	5.8
W	20	33	54	89	40	66	4	7					118	194	6.7
NW	49	81	147	242	96	158	7	12					299	493	6.5
N	16	26	48	79	36	59	1	2	1	2			102	168	6.6
CLM	2	3											2	3	0.0
TOT	110	181	289	476	192	316	14	23	2	3			607		6.4

MONTH AUG

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	1	2	4	7	2	3							7	11	6.4
E			2	3	3	5							5	8	7.4
SE	2	3	10	16	5	8	2	3					19	31	7.2
S	9	15	11	18	6	10							26	43	5.4
SW	3	5	9	15	8	13							20	33	6.8
W	19	31	61	100	35	57	3	5	1	2			119	195	6.6
NW	39	64	153	250	101	165	10	16	1	2			304	498	6.6
N	23	38	40	65	44	72	3	5					110	180	6.5
CLM	1	2											1	2	0.0
TOT	97	159	290	475	204	334	18	29	2	3			611		6.6

MONTH SEP

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	3	7	2	5			1	2					6	14	5.3
E	2	5	4	10	1	2							7	17	5.3
SE	5	12	5	12	2	5	1	2					13	31	5.4
S	11	26	7	17	3	7							21	50	3.7
SW	13	31	12	29	4	10							29	69	4.2
W	15	36	35	83	15	36	2	5					67	159	5.7
NW	61	145	90	214	45	107	6	14	3	7			205	487	5.8
N	16	38	31	74	20	48	1	2					68	162	5.9
CLM	5	12											5	12	0.0
TOT	131	311	186	442	90	214	11	26	3	7			421		5.5

(con.)

PERCENTAGE FREWUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1964-1983

MONTH MAY

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	38	79	95	197	70	145	10	21					213	441	6.5
E	4	8	9	19	4	8							17	35	5.6
SE	1	2	3	6	1	2							5	10	5.8
S	8	17	15	31	9	19	6	12	1	2			39	81	7.4
SW	5	10	16	33	11	23	2	4	1	2	1	2	36	75	7.7
W	1	2	2	4	1	2							4	8	5.3
NW			2	4	1	2							3	6	6.3
N	32	66	65	135	50	104	10	21					157	325	6.7
CLM	9	19											9	19	0.0
TOT	98	203	207	429	147	304	28	58	2	4	1	2	483		6.6

MONTH JUN

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	32	64	95	190	91	182	11	22					229	457	6.9
E	5	10	14	28	6	12							25	50	5.4
SE	1	2	4	8	1	2	1	2					7	14	6.7
S	7	14	9	18	8	16	6	12					30	60	7.9
SW	8	16	14	28	25	50	7	14	1	2			55	110	7.9
W															
NW			2	4									2	4	6.0
N	27	54	49	98	63	126	8	16			1	2	148	295	7.3
CLM	5	10											5	10	0.0
TOT	85	170	187	373	194	387	33	66	1	2	1	2	501		7.0

MONTH JUL

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	40	76	113	214	161	304	20	38					334	631	7.6
E	4	8	10	19	2	4							16	30	5.4
SE			4	8	2	4							6	11	6.2
S	8	15	6	11	6	11	7	13					27	51	7.7
SW	2	4	14	26	19	36							35	66	7.9
W			1	2	1	2							2	4	6.5
NW															
N	17	32	30	57	42	79	13	25					102	193	8.0
CLM	7	13											7	13	0.0
TOT	78	147	178	336	233	440	40	76					529		7.5

MONTH AUG

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	71	134	128	242	97	184	13	25					309	585	6.4
E	7	13	13	25	7	13							27	51	5.6
SE			2	4	1	2							3	6	6.0
S	2	4	11	21	17	32	4	8					34	64	8.9
SW	7	13	22	42	25	47	9	17	1	2	1	2	65	123	8.5
W					2	4							2	4	10.0
NW	1	2	1	2	2	4							4	8	6.3
N	8	15	26	49	35	66	4	8	1	2			74	140	8.1
CLM	10	19											10	19	0.0
TOT	106	201	203	384	186	352	30	57	2	4	1	2	528		6.9

MONTH SEP

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	73	153	133	278	64	134	5	10					275	575	5.5
E	5	10	12	25	6	13							23	48	5.7
SE	1	2	2	4	1	2			1	2			5	10	8.8
S	6	13	4	8	7	15	7	15	1	2			25	52	9.0
SW	12	25	9	19	14	29	7	15					42	88	7.1
W			1	2									1	2	7.0
NW	3	6	2	4									5	10	3.4
N	20	42	30	63	38	79	2	4	1	2			91	190	7.0
CLM	11	23											11	23	0.0
TOT	131	274	193	404	130	272	21	44	3	6			478		6.0

MONTH OCT

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	48	119	84	208	25	62	2	5	1	2			160	396	5.0
E	2	5	15	37	4	10							21	52	5.5
SE	3	7	2	5									5	12	3.2
S	6	15	14	35	6	15	4	10	2	5			32	79	7.8
SW	5	12	7	17	4	10	6	15					22	54	8.3
W			2	5			1	2					3	7	7.7
NW															
N	31	77	46	114	54	134	6	15					137	339	6.6
CLM	24	59											24	59	0.0
TOT	119	295	170	421	93	230	19	47	3	7			404		5.7

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1951-1970

MONTH MAY — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	11	58	20	105	24	126	8	42	1	5			64	337	7.7
E			3	16	3	16			1	5			7	37	8.9
SE	1	5	1	5	2	11							4	21	6.3
S	6	32	6	32	2	11			1	5			15	79	5.7
SW	2	11	4	21	4	21	1	5	2	11			13	68	8.8
W	1	5	1	5	1	5							3	16	5.7
NW					1	5							1	5	8.0
N	15	79	13	68	33	174	9	47					70	368	8.0
CLM	13	68											13	68	0.0
TOT	49	258	48	253	70	368	18	95	5	26			190		7.2

MONTH JUN — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	20	44	38	84	75	166	25	55					158	349	8.4
E	2	4	9	20	15	33	10	22					36	79	9.7
SE	1	2	2	4	1	2	2	4					6	13	8.7
S	5	11	13	29	11	24	4	9					33	73	7.6
SW	5	11	13	29	11	24							29	64	6.6
W	3	7	6	13	7	15	2	4					18	40	7.6
NW			4	9	5	11	2	4					11	24	9.5
N	17	38	39	86	72	159	9	20	1	2			138	305	7.9
CLM	24	53											24	53	0.0
TOT	77	170	124	274	197	435	54	119	1	2			453		7.7

MONTH JUL — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	8	15	51	97	134	255	47	90	4	8	1	2	245	467	9.9
E			5	10	20	38	8	15					33	63	10.5
SE	1	2	1	2	3	6	1	2					6	11	8.2
S	3	6	8	15	13	25	1	2	1	2			26	50	8.4
SW	3	6	16	30	14	27	6	11	1	2			40	76	8.6
W	1	2	4	8	4	8	1	2	1	2	1	2	12	23	10.6
NW			5	10	5	10							10	19	8.0
N	6	11	34	65	76	145	27	51	1	2	3	6	147	280	9.8
CLM	6	11											6	11	0.0
TOT	28	53	124	236	269	512	91	173	8	15	5	10	525		9.6

MONTH AUG — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	15	29	73	140	109	208	45	86	8	15			250	478	9.4
E	4	8	4	8	11	21	4	8					23	44	8.5
SE					2	4							2	4	9.5
S	2	4	10	19	18	34	6	11	1	2			37	71	9.6
SW	3	6	16	31	14	27	6	11					39	75	8.4
W			1	2	5	10	1	2	1	2			8	15	11.5
NW	1	2	6	11	1	2	1	2					9	17	6.9
N	12	23	42	80	70	134	21	40	5	10			150	287	9.1
CLM	5	10											5	10	0.0
TOT	42	80	152	291	230	440	84	161	15	29			523		9.1

MONTH SEP — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	17	38	56	126	68	153	20	45	8	18	1	2	170	382	8.7
E			10	22	8	18	2	4	1	2			21	47	8.4
SE			5	11	6	13			1	2			12	27	8.1
S	7	16	10	22	16	36	9	20					42	94	8.5
SW	7	16	12	27	9	20	8	18					36	81	7.8
W	1	2	2	4	4	9	3	7					10	22	10.1
NW			2	4	1	2							3	7	7.3
N	19	43	56	126	58	130	9	20	1	2			143	321	7.5
CLM	8	18											8	18	0.0
TOT	59	133	153	344	170	382	51	115	11	25	1	2	445		8.0

MONTH OCT — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	1	3	19	66	13	45	3	10					36	125	7.8
E	1	3	4	14									5	17	4.4
SE	1	3	2	7	1	3							4	14	5.8
S	9	31	20	69	7	24	6	21	3	10			45	156	7.7
SW	6	21	11	38	1	3					1	3	19	66	5.8
W	4	14	3	10	4	14	2	7					13	45	7.2
NW			1	3									1	3	4.0
N	30	104	51	177	57	198	7	24					145	503	6.7
CLM	20	69											20	69	0.0
TOT	72	250	111	385	83	288	18	63	3	10	1	3	288		6.4

(con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101019 HELLS HALF ACRE LO 1964-1983

MONTH JUL — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	26	48	70	129	32	59	1	2	1	2			130	240	5.8
E	6	11	11	20	2	4	1	2					20	37	5.6
SE	1	2	4	7	2	4	1	2	1	2			9	17	8.9
S	3	6	4	7	6	11	2	4	1	2			16	30	8.9
SW	28	52	71	131	57	105	14	26	1	2			171	315	7.1
W	17	31	39	72	36	66	11	20	1	2			104	192	7.6
NW	6	11	11	20	6	11	1	2					24	44	6.0
N	9	17	33	61	21	39	3	6	1	2			67	124	6.9
CLM	1	2											1	2	0.0
TOT	97	179	243	448	162	299	34	63	6	11			542		6.8

MONTH AUG — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	30	54	77	138	33	59	6	11					146	261	5.9
E	3	5	12	21	1	2	2	4			1	2	19	34	7.2
SE			3	5	4	7	3	5					10	18	10.7
S	1	2	7	13	4	7	1	2					13	23	7.3
SW	25	45	66	118	57	102	23	41	5	9	1	2	177	316	8.0
W	11	20	28	50	29	52	15	27	3	5	1	2	87	155	8.8
NW	4	7	7	13	13	23	4	7	1	2			29	52	9.2
N	6	11	33	59	36	64	4	7					79	141	7.6
CLM															
TOT	80	143	233	416	177	316	58	104	9	16	3	5	560		7.6

STATION NUMBER 101019 HELLS HALF [illegible] LO 1954-1970

MONTH JUL — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE			22	49	20	45	1	2					43	96	7.6
E			9	20	1	2	2	4					12	27	8.2
SE			3	7	3	7			2	4			8	18	10.4
S	3	7	3	7	5	11	5	11	1	2			17	38	10.5
SW	8	18	41	91	60	134	17	38	4	9	2	4	132	294	9.4
W	3	7	20	45	39	87	12	27	3	7			77	171	9.9
NW	2	4	27	60	46	102	8	18	1	2			84	187	8.8
N	4	9	34	76	35	78	2	4	1	2			76	169	8.0
CLM															
TOT	20	45	159	354	209	465	47	105	12	27	2	4	449		9.0

MONTH AUG — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	1	2	24	51	19	40	3	6	1	2			48	101	7.8
E			4	8			3	6	1	2	1	2	9	19	14.2
SE			2	4	2	4			1	2			5	11	9.6
S			2	4	3	6	1	2					6	13	9.2
SW	6	13	28	59	56	118	27	57	8	17	1	2	126	266	10.5
W	2	4	16	34	41	87	18	38	4	8	1	2	82	173	10.5
NW	7	15	41	87	56	118	24	51					128	271	8.9
N	4	8	28	59	31	66	4	8	1	2			68	144	8.0
CLM	1	2											1	2	0.0
TOT	21	44	145	307	208	440	80	169	16	34	3	6	473		9.4

STATION NUMBER 101023 JERSEY MTN LO 1959-1970

MONTH JUL — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	2	6	4	11	2	6	1	3					9	26	6.1
E	1	3	4	11	5	14	1	3					11	32	7.8
SE	2	6	1	3	1	3							4	11	4.0
S			3	9	1	3							4	11	6.0
SW	24	69	36	103	15	43	5	14	1	3			81	232	5.8
W	30	86	90	258	72	206	23	66	2	6	1	3	218	625	7.7
NW	2	6	10	29	4	11							16	46	5.9
N	2	6	1	3	2	6							5	14	5.2
CLM	1	3											1	3	0.0
TOT	64	183	149	427	102	292	30	86	3	9	1	3	349		7.1

MONTH AUG — WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	3	9	1	3									4	12	2.8
E	9	27	4	12	2	6			1	3			16	48	4.9
SE			2	6									2	6	4.5
S	1	3	2	6			2	6			1	3	6	18	13.2
SW	13	39	31	94	19	58	4	12			1	3	68	206	6.8
W	23	70	79	239	70	212	21	64	3	9	1	3	197	597	7.9
NW	4	12	9	27	14	42	1	3	1	3			29	88	7.3
N	3	9	3	9									6	18	4.0
CLM	2	6											2	6	0.0
TOT	58	176	131	397	105	318	28	85	5	15	3	9	330		7.4

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101801 BONANZA GS 1971-1983

MONTH JUL

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	5	13	24	61	8	20	1	3					38	96	5.9
E	2	5	5	13									7	18	4.0
SE	3	8	16	41	10	25	1	3					30	76	6.9
S	8	20	23	58	18	46	4	10					53	135	6.9
SW	16	46	85	216	42	107	6	15					151	383	6.6
W	8	20	20	51	11	28	1	3					40	102	6.0
NW	2	5	13	33	10	25	1	3					26	66	7.0
N	11	28	22	56	7	18	1	3					41	104	5.4
CLM	8	20											8	20	0.0
TOT	65	165	208	528	106	269	15	38					394		6.2

MONTH AUG

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	9	22	23	57	8	20							40	100	5.4
E	1	2	7	17	3	7							11	27	6.2
SE	8	20	24	60	3	7	1	2	1	2			37	92	5.7
S	17	42	22	55	13	32	1	2					53	132	5.5
SW	35	87	100	249	32	80	1	2					168	418	5.4
W	5	12	13	32	7	17							25	62	6.0
NW	3	7	8	20	7	17							18	45	6.5
N	5	12	16	40	12	30							33	82	6.2
CLM	17	42											17	42	0.0
TOT	100	249	213	530	85	211	3	7	1	2			402		5.4

MONTH SEP

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	8	22	9	25	3	8							20	55	4.6
E	1	3	8	22	1	3							10	28	5.5
SE	14	39	25	69	4	11							43	118	4.6
S	27	74	31	85	11	30							69	190	4.6
SW	37	102	77	212	20	55	2	6					136	375	5.2
W	10	28	18	50	5	14							33	91	5.1
NW	4	11	2	6	4	11							10	28	6.2
N	5	14	15	41	2	6	2	6					24	66	5.6
CLM	18	50											18	50	0.0
TOT	124	342	185	510	50	138	4	11					363		4.8

STATION NUMBER 101207 LANDMARK RS 1971-1981

MONTH JUL

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	3	10	1	3	2	6							6	19	5.3
E	1	3	5	16	2	6							8	25	5.4
SE	1	3	3	10	1	3							5	16	5.4
S	2	6	10	32	11	35	1	3					24	76	7.8
SW	7	22	37	117	33	105	1	3					78	248	6.9
W	11	35	97	308	38	121	5	16					151	479	6.5
NW	1	3	20	63	7	22	1	3					29	92	6.9
N	2	6	7	22	3	10							12	38	5.7
CLM	2	6											2	6	0.0
TOT	30	95	180	571	97	308	8	25					315		6.6

MONTH AUG

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	2	6	6	18	2	6							10	30	5.5
E	5	15	8	24									13	39	4.0
SE			3	9									3	9	6.3
S	2	6	18	54	15	45							35	104	6.7
SW	4	12	34	101	25	75	3	9					66	197	7.5
W	15	45	99	296	48	143	2	6					164	490	6.4
NW	7	21	20	60	7	21							34	101	5.4
N	4	12	5	15	1	3							10	30	4.4
CLM															
TOT	39	116	193	576	98	293	5	15					335		6.4

MONTH SEP

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	2	7	4	13	5	17							11	36	6.5
E	2	7	6	20	1	3							9	30	4.8
SE			6	20	1	3							7	23	5.6
S	3	10	9	30	8	26							20	66	6.8
SW	13	43	20	66	22	73	2	7					57	188	6.5
W	24	79	95	314	27	89							146	482	5.7
NW	9	30	23	76	6	20							38	125	5.3
N	3	10	10	33	1	3	1	3					15	50	5.3
CLM															
TOT	56	185	173	571	71	234	3	10					303		5.9

(con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101204 CASCADE RS 1971-1983

MONTH MAY

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	5	31	4	25	1	6							10	62	4.3
E	2	12	4	25	1	6							7	43	4.7
SE	2	12	11	68	1	6	I	6					15	93	5.8
S	2	12	2	12									4	25	4.0
SW	2	12	4	25									6	37	4.8
W	9	56	26	160	5	31							40	247	5.2
NW	6	37	37	228	22	136							65	401	6.2
N	1	6	12	74	2	12							15	93	6.1
CLM															
TOT	29	179	100	617	32	198	I	6					162		5.6

MONTH JUN

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	8	31	7	27									15	58	3.5
E	7	27	3	12	2	8							12	46	3.9
SE	7	27	13	50	2	8							22	85	4.5
S	7	27	10	38	1	4							18	69	4.1
SW	10	38	6	23	1	4							17	65	3.8
W	24	92	45	173	6	23	1	4					76	292	4.6
NW	29	112	47	181	8	31	1	4					85	327	4.3
N	6	23	5	19	2	8							13	50	4.8
CLM	2	8											2	8	0.0
TOT	100	385	136	523	22	85	2	8					260		4.3

MONTH JUL

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	12	32	8	22									20	54	3.4
E	6	16	13	35	I	3							20	54	4.4
SE	9	24	18	48									27	73	4.4
S	19	51	17	46	2	5							38	102	3.9
SW	9	24	16	43	3	8							28	75	4.6
W	22	59	83	223	8	22							113	304	4.8
NW	29	78	68	183	9	24							106	285	4.8
N	3	8	12	32	3	8							18	48	5.4
CLM	2	5											2	5	0.0
TOT	111	298	235	632	26	70							372		4.6

MONTH AUG

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	6	17	7	19	1	3							14	39	4.2
E	7	19	10	28	4	11							21	58	4.8
SE	11	31	24	67	2	6							37	103	4.5
S	10	28	12	33	2	6							24	67	4.1
SW	8	22	15	42	2	6							25	69	4.3
W	34	94	56	156	4	11							94	261	4.2
NW	30	83	77	214	7	19	1	3					115	319	4.9
N	9	25	17	47	2	6							28	78	4.4
CLM	2	6											2	6	0.0
TOT	117	325	218	606	24	67	1	3					360		4.5

MONTH SEP

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	9	28	11	34									20	61	3.5
E	7	21	14	43	4	12							25	77	4.9
SE	12	37	16	49	4	12							32	98	4.6
S	8	25	6	18	2	6							16	49	4.1
SW	6	18	9	28	3	9							18	55	4.7
W	27	83	54	166	9	28							90	276	4.7
NW	33	101	55	169	15	46							103	316	4.8
N	7	21	10	31	2	6							19	58	4.1
CLM	3	9											3	9	0.0
TOT	112	344	175	537	39	120							326		4.6
TOT															

MONTH OCT

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	9	42	3	14			1	5					13	61	3.5
E	8	37	5	23									13	61	3.4
SE	10	47	11	51	2	9							23	107	4.0
S	5	23	3	14									8	37	3.4
SW	7	33	3	14									10	47	2.9
W	39	182	26	121	5	23							70	327	3.7
NW	23	107	31	145	9	42	2	9					65	304	4.8
N	4	19	4	19	1	5							9	42	4.1
CLM	3	14											3	14	0.0
TOT	108	505	86	402	17	79	3	14					214		4.0

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101803 CHALLIS RS 1971-1983

MONTH MAY

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE			1	26	1	26							2	53	7.0
E	3	79	3	79									6	158	3.2
SE	1	26	3	79	1	26							5	132	5.0
S			1	26	1	26							2	53	7.0
SW					1	26			1	26			2	53	15.5
W	3	79	3	79	1	26	2	53					9	237	7.1
NW			3	79									3	79	5.7
N			8	211	1	26							9	237	5.9
CLM															
TOT	7	184	22	579	6	158	2	53	1	26			38		6.2

MONTH JUN

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	17	60	26	92	2	7							45	160	4.1
E	10	35	31	110	6	21							47	167	5.2
SE	7	25	16	57	5	18	1	4					29	103	5.5
S	3	11	11	39	4	14	8	28	1	4			27	96	9.0
SW	6	21	11	39	26	92	4	14	4	14			51	181	9.5
W	7	25	9	32	14	50	8	28	3	11			41	145	9.3
NW	1	4	12	43	4	14	1	4					18	64	6.4
N	9	32	12	43	2	7	1	4					24	85	5.0
CLM															
TOT	60	213	128	454	63	223	23	82	8	28			282		6.9

MONTH JUL

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	27	70	30	78	3	8	1	3					61	158	4.2
E	10	26	56	145	10	26							76	196	5.2
SE	10	26	16	41	9	23	1	3					36	93	5.9
S	3	8	11	28	10	26	9	23	3	8	1	3	37	96	10.5
SW	4	10	18	47	35	90	10	26	1	3			68	176	9.1
W	10	26	11	28	18	47	10	26					49	127	8.6
NW	10	26	9	23	8	21	2	5			1	3	30	78	6.9
N	10	26	14	36	3	8	1	3					28	72	4.9
CLM	2	5											2	5	0.0
TOT	86	222	165	426	96	248	34	88	4	10	2	5	387		6.8

MONTH AUG

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	31	77	37	92	2	5	2	5					72	179	4.3
E	35	87	54	134	3	7	1	2					93	231	4.2
SE	13	32	28	70	8	20	2	5	1	2			52	129	5.7
S	8	20	5	12	8	20	1	2					22	55	6.5
SW	11	27	17	42	22	55	11	27	1	2			62	154	8.5
W	6	15	6	15	17	42	1	2					30	75	7.8
NW	18	45	11	27	4	10	3	7					36	90	5.0
N	20	50	13	32			1	2					34	85	3.3
CLM	1	2											1	2	0.0
TOT	143	356	171	425	64	159	22	55	2	5			402		5.5

MONTH SEP

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	47	124	13	34	5	13	1	3					66	174	3.5
E	38	100	29	77	3	8	1	3					71	187	3.7
SE	23	61	10	26	9	24	3	8					45	119	5.1
S	9	24	10	26	6	16	1	3					26	69	5.7
SW	11	29	19	50	19	50	8	21					57	150	7.5
W	5	13	7	18	6	16	3	8					21	55	7.2
NW	22	58	9	24	5	13	3	8	1	3			40	106	5.4
N	32	84	11	29	5	13							48	127	3.5
CLM	5	13											5	13	0.0
TOT	192	507	108	285	58	153	20	53	1	3			379		4.8

MONTH OCT

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	16	92	4	23	1	6							21	121	3.1
E	21	121	6	35	1	6							28	162	2.8
SE	6	35	4	23	1	6							11	64	4.0
S	9	52	1	6	2	12							12	69	3.4
SW	10	58	10	58	4	23					1	6	25	145	5.7
W	3	17	6	35	4	23	1	6					14	81	6.4
NW	6	35	3	17	1	6							10	58	3.9
N	25	145	8	46	3	17							36	208	3.4
CLM	16	92											16	92	0.0
TOT	112	647	42	243	17	98	1	6			1	6	173		3.6

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101303 INDIANOLA RS 1971-1983

MONTH MAY

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	27	70	2	5	1	3							30	77	0.9
E	17	44	26	67	12	31	1	3					56	144	5.4
SE	31	80	38	98	16	41	5	13					90	232	5.8
S	11	28	13	34	10	26	1	3					35	90	5.7
SW	17	44	41	106	33	85	16	41			1	3	108	278	8.1
W	7	18	25	64	9	23	2	5	1	3			44	113	6.3
NW	2	5	3	8	3	8	1	3					9	23	7.0
N	4	10	2	5	4	10							10	26	5.3
CLM	6	15											6	15	0.0
TOT	122	314	150	387	88	227	26	67	1	3	1	3	388		6.0

MONTH JUN

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	12	31	4	10	1	3							17	44	2.1
E	24	62	33	85	13	33	3	8	1	3			74	190	5.8
SE	30	77	37	95	18	46	14	36			1	3	100	257	6.7
S	5	13	6	15	2	5	1	3					14	36	5.2
SW	12	31	26	67	25	64	9	23	2	5			74	190	7.8
W	19	49	27	69	17	44	4	10					67	172	6.0
NW			6	15	12	31	5	13	1	3	1	3	25	64	11.1
N	2	5	1	3	1	3	2	5	1	3			7	18	11.1
CLM	11	28											11	28	0.0
TOT	115	296	140	360	89	229	38	98	5	13	2	5	389		6.5

MONTH JUL

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	7	18	2	5	6	15							15	38	4.8
E	21	54	22	56	10	26							53	136	4.7
SE	29	74	44	113	20	51	3	8					96	246	5.5
S	7	18	15	38	7	18							29	74	5.5
SW	19	49	32	82	16	41	1	3					68	174	5.7
W	25	64	29	74	15	38	3	8	1	3			73	187	5.7
NW	2	5	15	38	13	33	8	20	2	5			40	102	9.1
N	1	3	2	5	4	10	2	5	1	3			10	26	9.8
CLM	7	18											7	18	0.0
TOT	118	302	161	412	91	233	17	43	4	10			391		5.8

MONTH AUG

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	4	10					1	3					5	13	2.6
E	35	88	21	53	7	18	1	3					64	161	4.0
SE	39	98	54	136	13	33	1	3	1	3			108	272	5.0
S	4	10	4	10	5	13	1	3					14	35	6.7
SW	12	30	33	83	27	68	6	15					78	196	6.9
W	28	71	34	86	12	30							74	186	4.6
NW	2	5	13	33	8	20							23	58	6.7
N	1	3	3	8	4	10	1	3					9	23	7.9
CLM	22	55											22	55	0.0
TOT	147	370	162	408	76	191	11	28	1	3			397		5.0

MONTH SEP

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	5	13	1	3	2	5							8	21	3.5
E	37	97	24	63	7	18							68	178	3.9
SE	18	47	55	144	20	52	1	3					94	245	5.6
S	11	29	18	47	4	10							33	86	4.8
SW	15	39	38	99	26	68	2	5	2	5			83	217	6.5
W	18	47	21	55	3	8	1	3					43	112	4.3
NW			4	10	4	10					1	3	9	23	9.4
N	4	10	4	10	2	5	1	3					11	29	6.1
CLM	34	89											34	89	0.0
TOT	142	371	165	431	68	178	5	13	2	5	1	3	383		4.9

MONTH OCT

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	22	88											22	88	0.6
E	21	84	15	60	6	24	1	4					43	173	4.0
SE	23	92	32	129	11	44	1	4					67	269	4.9
S	6	24	13	52	1	4							20	80	4.4
SW	12	48	20	80	14	56	1	4					47	189	6.1
W	7	28	12	48	8	32	2	8					29	116	6.1
NW	2	8	2	8	1	4							5	20	4.6
N							1	4					1	4	17.0
CLM	15	60											15	60	0.0
TOT	108	434	94	378	41	165	6	24					249		4.4

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101206 KRASSEL RS 1971-1983

MONTH MAY

WIND SPEED, MPH

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	5	25	4	20									9	44	2.1
E			1	5									1	5	4.0
SE	2	10	2	10									4	20	3.5
S	3	15	41	202	17	84	1	5					62	305	6.4
SW			7	34	4	20							11	54	6.5
W	3	15	2	10									5	25	4.0
NW	8	39	15	74	7	34							30	148	5.1
N	7	34	40	197	31	153	3	15					81	399	7.1
CLM															
TOT	28	138	112	552	59	291	4	20					203		6.2

MONTH JUN

WIND SPEED, MPH

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	6	23	6	23	1	4							13	49	3.5
E	2	8											2	8	1.5
SE	2	8	5	19	2	8							9	34	5.8
S	11	42	60	228	33	125	2	8					106	403	6.5
SW	9	34	19	72	13	49							41	156	5.7
W	3	11	5	19									8	30	3.5
NW	2	8	8	30	1	4							11	42	5.1
N	7	27	36	137	22	84	3	11	1	4			69	262	7.0
CLM	4	15											4	15	0.0
TOT	46	175	139	529	72	274	5	19	1	4			263		6.0

MONTH JUL

WIND SPEED, MPH

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	10	26	5	13	2	5							17	45	2.9
E			1	3									1	3	4.0
SE	5	13	5	13	4	11							14	37	5.3
S	21	55	83	218	103	271	13	34	3	8			223	587	7.8
SW	9	24	20	53	8	21	3	8					40	105	6.1
W															
NW	4	11	3	8	1	3							8	21	3.8
N	11	29	31	82	21	55	5	13	1	3			69	182	7.1
CLM	8	21											8	21	0.0
TOT	68	179	148	389	139	366	21	55	4	11			380		7.0

MONTH AUG

WIND SPEED, MPH

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	5	13	5	13	1	3							11	28	4.2
E			1	3	1	3	1	3					3	8	9.0
SE	5	13	6	15	2	5							13	33	4.5
S	13	33	81	207	111	283	15	38					220	561	8.1
SW	7	18	20	51	13	33			1	3			41	105	6.5
W	1	3	3	8									4	10	5.0
NW	3	8	7	18	1	3							11	28	4.7
N	11	28	36	92	31	79	6	15					84	214	7.2
CLM	5	13											5	13	0.0
TOT	50	128	159	406	160	408	22	56	1	3			392		7.3

MONTH SEP

WIND SPEED, MPH

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	5	14	9	25	2	6							16	45	4.3
E	2	6											2	6	2.5
SE	2	6	3	8	1	3							6	17	4.7
S	38	106	70	196	39	109	12	34	1	3			160	447	6.4
SW	5	14	4	11	10	28	5	14					24	67	8.4
W	6	17	4	11	3	8							13	36	4.5
NW	5	14	5	14	4	11	1	3					15	42	5.5
N	17	47	60	168	27	75	4	11					108	302	6.4
CLM	14	39											14	39	0.0
TOT	94	263	155	433	86	240	22	61	1	3			358		6.1

WIND SPEED, MPH

	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
DIR.	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101805 LITTLE CREEK GS 1971-1983

MONTH JUN

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	14	41	9	27	6	18	3	9	2	6			34	100	6.1
E	9	27	9	27	6	18							24	71	5.0
SE	9	27	19	56	12	35	4	12					44	130	7.0
S	10	29	22	65	31	91	13	38	5	15			81	239	9.5
SW	13	38	22	65	26	77	6	18	4	12			71	209	8.3
W	7	21	19	56	9	27	2	6			1	3	38	112	6.9
NW	2	6	12	35	4	12	1	3					19	56	6.3
N	14	41	9	27	2	6							25	74	3.8
CLM	3	9											3	9	0.0
TOT	81	239	121	357	96	283	29	86	11	32	1	3	339		7.3

MONTH JUL

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	21	53	16	41	4	10							41	104	4.2
E	15	38	16	41	3	8	2	5					36	92	4.8
SE	16	41	21	53	13	33	11	28	2	5			63	160	7.5
S	10	25	25	64	35	89	30	76	8	20			108	275	10.5
SW	6	15	12	31	33	84	17	43	6	15			74	188	10.6
W	4	10	7	18	19	48	8	20			1	3	39	99	9.5
NW	1	3	8	20	6	15	3	8					18	46	8.1
N	4	10	8	20	1	3	1	3					14	36	5.1
CLM															
TOT	77	196	113	288	114	290	72	183	16	41	1	3	393		8.5

MONTH AUG

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	12	30	16	40	3	8	1	3					32	80	4.3
E	14	35	26	65	3	8	3	8					46	115	4.8
SE	24	60	23	58	14	35	11	28	4	10			76	190	7.4
S	15	38	28	70	25	63	18	45	2	5	2	5	90	226	8.9
SW	7	18	18	45	15	38	22	55	8	20	1	3	71	178	11.4
W	2	5	12	30	6	15	8	20	4	10			32	80	10.6
NW	8	20	8	20	4	10	2	5	1	3	1	3	24	60	7.3
N	12	30	11	28	2	5							25	63	4.3
CLM	3	8											3	8	0.0
TOT	97	243	142	356	72	180	65	163	19	48	4	10	399		7.9

MONTH SEP

WIND SPEED, MPH

DIR.	0-3 N.	0-3 PCT	4-7 N.	4-7 PCT	8-12 N.	8-12 PCT	13-18 N.	13-18 PCT	19-24 N.	19-24 PCT	>24 N.	>24 PCT	TOTAL N.	TOTAL PCT	AVG SPEED
NE	26	76	8	23	2	6							36	106	3.3
E	56	164	13	38	3	9							72	211	3.0
SE	36	106	7	21	4	12	1	3					48	141	3.6
S	23	67	11	32	23	67	13	38	2	6			72	211	7.9
SW	13	38	14	41	13	38	4	12	1	3			45	132	6.7
W	3	9	7	21	8	23	4	12					22	65	8.2
NW	3	9	3	9	6	18	1	3					13	38	7.6
N	16	47	7	21	6	18	1	3					30	88	4.7
CLM	3	9											3	9	0.0
TOT	179	525	70	205	65	191	24	70	3	9			341		5.3

(con.)

Table 27 (Con.)

PERCENTAGE FREQUENCY OF OCCURRENCE BY DIRECTION FOR SELECTED SPEED INCREMENTS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101209 MC CALL SO 1971-1983

MONTH MAY

WIND SPEED, MPH

DIR.	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	19	57	10	30	6	18	2	6					37	111	4.0
E	3	9	6	18	2	6							11	33	5.0
SE			4	12	1	3	1	3	1	3			7	21	9.1
S	4	12	7	21	3	9							14	42	5.1
SW	15	45	31	93	21	63	4	12					71	213	6.3
W	5	15	34	102	27	81	1	3					67	201	6.9
NW	8	24	40	120	15	45							63	189	6.0
N	8	24	26	78	24	72	1	3					59	177	6.8
CLM	4	12											4	12	0.0
TOT	66	198	158	474	99	297	9	27	1	3			333		6.1

MONTH JUN

WIND SPEED, MPH

DIR.	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	6	18	9	27			1	3					16	48	4.6
E	5	15	6	18	2	6							13	39	4.3
SE	9	27	9	27	3	8	3	9					24	71	5.6
S	7	21	11	33	9	27	3	9					30	89	6.7
SW	11	33	57	170	30	89	5	15					103	307	6.7
W	21	63	28	83	21	63	1	3					71	211	6.0
NW	10	30	38	113	10	30	2	6					60	179	6.2
N	4	12	9	27	2	6	1	3					16	48	6.0
CLM	3	9											3	9	0.0
TOT	76	226	167	497	77	229	16	48					336		6.1

MONTH JUL

WIND SPEED, MPH

DIR.	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	8	22	7	19	1	3							16	43	3.5
E	3	8	2	5	1	3							6	16	4.0
SE	7	19	12	33	4	11	1	3					24	65	5.7
S	16	43	35	95	20	54	1	3					72	195	5.8
SW	20	54	49	133	18	49	8	22	1	3			96	260	6.5
W	17	46	36	98	22	60	2	5					77	209	6.0
NW	11	30	26	70	7	19	2	5					46	125	5.5
N	13	35	8	22	3	8	1	3					25	68	4.6
CLM	7	19											7	19	0.0
TOT	102	276	175	474	76	206	15	41	1	3			369		5.7

MONTH AUG

WIND SPEED, MPH

DIR.	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	12	33	8	22	1	3							21	58	3.5
E	4	11	3	8									7	19	3.7
SE	2	5	16	44	4	11	1	3					23	63	5.9
S	21	58	35	96	12	33	5	14					73	200	5.8
SW	25	68	49	134	30	82	9	25	2	5			115	315	6.7
W	15	41	31	85	15	41	3	8					64	175	6.1
NW	13	36	17	47	4	11							34	93	4.7
N	11	30	8	22	2	5							21	58	4.0
CLM	7	19											7	19	0.0
TOT	110	301	167	458	68	186	18	49	2	5			365		5.6

MONTH SEP

WIND SPEED, MPH

DIR.	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED
NE	6	18	2	6	1	3							9	27	3.1
E	2	6	2	6	1	3							5	15	4.4
SE	3	9	9	27	4	12							16	48	5.4
S	30	91	25	76	9	27							64	194	4.3
SW	38	115	35	106	25	76	5	15					103	312	5.7
W	12	36	28	85	15	45							55	167	5.8
NW	15	45	23	70	9	27	1	3					48	145	5.2
N	8	24	8	24	5	15							21	64	5.1
CLM	9	27											9	27	0.0
TOT	123	373	132	400	69	209	6	18					330		5.1

WIND SPEED, MPH

DIR.	0-3		4-7		8-12		13-18		19-24		>24		TOTAL		AVG
	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	N.	PCT	SPEED

Table 28—Frequencies of three-way combinations of afternoon dry bulb temperature (°F), relative humidity (percent), and windspeed (miles/hour), during fire season. Based on data observed during 1964-83 (see table 25 caption)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

MONTH JUN

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		8								
95-99		8	8							
90-94		8	3							
85-89		10	28	3	5					
80-84		5	13	15	3					
75-79		3	8	13	5					
70-74			5	8	5	8		3		
65-69			3	3	10	13	3	8		
60-64				3		5	5	8	3	
55-59							8	18	15	
50-54								5	5	
45-49										3
40-44										
35-39										
30-34										
<30										
TOTAL		41	67	44	28	26	15	41	23	3
NUMBER	0	16	26	17	11	10	6	16	9	1

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		3	3							
95-99		23	3							
90-94		28	23	8						
85-89		33	44	10	3					
80-84		21	49	21	3					
75-79		18	23	23	3					
70-74			28	31	15	5		3		
65-69			8	13	15	13	5			
60-64				10	18		8	5	3	
55-59				3	8	3		8	8	
50-54						3			3	
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		126	179	118	64	23	13	15	13	
NUMBER	0	49	70	46	25	9	5	6	5	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		3								
95-99		5								
90-94		5								
85-89	3	10	15	3						
80-84		5	8							
75-79	3	8	10		3					
70-74			3	8	3	3			3	
65-69			3	3	3			3		
60-64				3	3	3				
55-59				3						
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	36	38	18	10	5		3	3	
NUMBER	2	14	15	7	4	2	0	1	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94			3							
85-89			3							
80-84		5		3						
75-79			3							
70-74				5						
65-69				3						
60-64					3					
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		5	8	10	3					
NUMBER	0	2	3	4	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		3								
85-89										
80-84				3						
75-79				3						
70-74										
65-69										
60-64							3			
55-59								3		
50-54						3				
45-49								3		
40-44										
35-39										
30-34										
<30										
TOTAL		3		5		3	3	5		
NUMBER	0	1	0	2	0	1	1	2	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	15	6
95-99	46	18
90-94	79	31
85-89	169	66
80-84	151	59
75-79	123	48
70-74	133	52
65-69	105	41
60-64	79	31
55-59	74	29
50-54	18	7
45-49	5	2
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		390

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

MONTH JUL

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	11	4								
95-99	4	19	17	2						
90-94		9	6	6						
85-89		4	13	6	2					
80-84		6	4	13	4					
75-79			2	2	4	2	6			
70-74						4	2			
65-69						2		2	9	
60-64							4			
55-59									4	
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	15	43	43	30	11	9	13	2	13	
NUMBER	7	20	20	14	5	4	6	1	6	0

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	24	32	2							
95-99	22	82	15	2						
90-94	4	82	47	26						
85-89		41	32	17	4	2				
80-84		9	45	34	13					
75-79		2	13	9	9					
70-74		2	2	6		4	4			
65-69		2		4	4	9		2		
60-64						2				2
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	49	252	157	99	30	17	4	2		2
NUMBER	23	117	73	46	14	8	2	1	0	1

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	24	6								
95-99	9	30								
90-94		22	9							
85-89		6	9	2						
80-84		6	11	2	4					
75-79		4	4	2	2	2				
70-74			2	9	2	2				
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	32	75	34	15	9	4				
NUMBER	15	35	16	7	4	2	0	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99	2	2								
90-94		9	2							
85-89	2	2	2							
80-84			2							
75-79		2		2						
70-74					2					
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	6	15	6	2	2					
NUMBER	3	7	3	1	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100	2										108	50
95-99	2										209	97
90-94	2										224	104
85-89											146	68
80-84											155	72
75-79											69	32
70-74											43	20
65-69											34	16
60-64											9	4
55-59											4	2
50-54												0
45-49												0
40-44												0
35-39												0
30-34												0
<30												0
TOTAL	6										1000	
NUMBER	3	0	0	0	0	0	0	0	0	0		465

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

MONTH AUG

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	4									
95-99	2	6								
90-94		15								
85-89		4	13							
80-84		2	11	13	2					
75-79			2	9	4		2			
70-74				6	6					
65-69				2	6	9	6		6	
60-64				2	2	2	2		2	
55-59							2	6	11	
50-54								2	2	
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	6	28	26	32	22	11	13	9	22	
NUMBER	3	13	12	15	10	5	6	4	10	0

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	45	32								
95-99	28	71	6							
90-94	15	82	13							
85-89	2	13	52	6	2					
80-84	2	11	32	15	6	2				
75-79		9	15	24	9	9	4			
70-74	2		4	13	6	6	4	2		
65-69				4	9	2	4			
60-64									2	
55-59								4	2	
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	95	217	123	62	32	19	13	6	4	
NUMBER	44	101	57	29	15	9	6	3	2	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	22	22								
95-99	15	30								
90-94	11	17	9							
85-89	2	15	4	4						
80-84		2	19							
75-79		2	2							
70-74				2	2					
65-69				2		2		2		
60-64					2					
55-59						2				
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	49	88	34	9	4	4		2		
NUMBER	23	41	16	4	2	2	0	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	9	6								
95-99	9	[illegible]								
90-94	2	2								
85-89		6								
80-84		2		2						
75-79			2							
70-74										
65-69				2						
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	19	26	2	4						
NUMBER	9	12	1	2	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99		2								
90-94	4	4								
85-89										
80-84				2						
75-79										
70-74										
65-69							2			
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	6	6		2			2			
NUMBER	3	3	0	1	0	0	1	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	142	66
95-99	178	83
90-94	174	81
85-89	125	58
80-84	125	58
75-79	92	43
70-74	56	26
65-69	60	28
60-64	15	7
55-59	28	13
50-54	4	2
45-49		0
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		465

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101039 CAMPBELLS FERRY 1964-1978

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99										
90-94		15	2							
85-89		5	7	5						
80-84		10	46	7						
75-79		7	22	31	2					
70-74		12	34	34	12		2			
65-69			15	10	19	7	2	5	2	
60-64		5		7	7	10	7	5	2	2
55-59				2	7	2	5	7	7	
50-54							2	5	12	5
45-49									2	
40-44								2		2
35-39										
30-34										
<30										
TOTAL	2	53	126	97	48	19	19	24	27	10
NUMBER	1	22	52	40	20	8	8	10	11	4

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2	2								
95-99	2	17	5							
90-94	2	24								
85-89	5	41	12							
80-84	2	19	39	10						
75-79	5	29	31	12						
70-74		5	29	10	2	2	2			
65-69	2	2	19	15	22	7				
60-64			5	7	7	5	7			
55-59			5	7	2	2	2	5	2	
50-54			2	2	2				7	
45-49								2		
40-44										
35-39										
30-34										
<30										
TOTAL	22	140	148	63	36	17	12	7	10	
NUMBER	9	58	61	26	15	7	5	3	4	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2									
90-94	2	2								
85-89		7	2							
80-84		2	5							
75-79			5							
70-74		5	5	2	5					
65-69		7	5	7	2		2		2	
60-64			2	5						
55-59								2		
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	24	24	15	7		2	2	2	
NUMBER	2	10	10	6	3	0	1	1	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		2								
95-99										
90-94										
85-89		2	2							
80-84	2	2	2							
75-79		2								
70-74										
65-69			2		2					
60-64			2							
55-59				2						
50-54			2							
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	10	12	2	2					
NUMBER	1	4	5	1	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2									
90-94										
85-89										
80-84		2								
75-79										
70-74										
65-69										
60-64						2				
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	2				2				
NUMBER	1	1	0	0	0	1	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	10	4
95-99	29	12
90-94	48	20
85-89	90	37
80-84	150	62
75-79	148	61
70-74	162	67
65-69	160	66
60-64	90	37
55-59	63	26
50-54	41	17
45-49	5	2
40-44	5	2
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		413

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1964-1983

MONTH JUN

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94			8							
85-89		4	2	8	2	2				
80-84	2	10	12	8	2					
75-79			20	33	4		2			
70-74		8	14	23	14	8				
65-69			8	27	20	8	2	2	2	
60-64		2	4	12	23	20	25	10	6	
55-59			2	6	10	8	25	12	18	4
50-54				4	2	4	10	23	14	6
45-49					4	2	6	16	8	12
40-44									6	4
35-39									2	2
30-34										
<30										
TOTAL	2	25	72	121	82	53	70	64	57	29
NUMBER	1	12	35	59	40	26	34	31	28	14

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2	4	2	2					
80-84		6	18	2	4					
75-79		8	18	23	2	4				
70-74		4	16	18	14	6				
65-69		2	6	20	20	8	2			
60-64					8	2	8			
55-59				4	2	10	4	2	2	
50-54				4	2	8	4	4	4	
45-49						2	4	8	2	
40-44								4		
35-39										
30-34										
<30										
TOTAL		23	64	74	55	41	23	18	8	
NUMBER	0	11	31	36	27	20	11	9	4	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84		2	2				2			
75-79		4	4	8	6					
70-74		2	6	10	2					
65-69				6	4	2				
60-64			4	4	6		4			
55-59					2	4	2			
50-54					2	2			4	
45-49						2				
40-44										
35-39										
30-34										
<30										
TOTAL		10	16	29	23	10	8		4	
NUMBER	0	5	8	14	11	5	4	0	2	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2	2							
80-84			4							
75-79			2							
70-74					2					
65-69										
60-64										
55-59				2						
50-54										
45-49										
40-44								2		
35-39										
30-34										
<30										
TOTAL		2	8	2	2			2		
NUMBER	0	1	4	1	1	0	0	1	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79					2					
70-74			2							
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL			2		2					
NUMBER	0	0	1	0	1	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94	8	4
85-89	35	17
80-84	76	37
75-79	141	69
70-74	152	74
65-69	141	69
60-64	139	68
55-59	121	59
50-54	98	48
45-49	68	33
40-44	16	8
35-39	4	2
30-34		0
<30		0
TOTAL	1000	
NUMBER		488

(con.)

Table 28 (Con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		8	7							
85-89		24	29	5	2		2			
80-84		5	33	20	8		2			
75-79		3	29	23	23	2				
70-74			5	8	29	11	5	2		
65-69			3	10	11	18	10	10	3	2
60-64					2	10	7	2	2	2
55-59					7	5	3	8	7	3
50-54						2	5	2	2	5
45-49								2		2
40-44										
35-39										
30-34										
<30										
TOTAL		41	106	65	81	47	33	24	13	13
NUMBER	0	25	65	40	50	29	20	15	8	8

WIND SPEED 5-9 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		7	3							
85-89	3	33	29	5						
80-84	3	28	67	42	7	2				
75-79		7	16	46	18	2				
70-74		2	8	29	21	3		2		
65-69			3	8	16	11	2	2		
60-64				3	7	2	5	2		2
55-59				2	2	3	2	3		2
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	7	75	127	135	70	23	8	8		3
NUMBER	4	46	78	83	43	14	5	5	0	2

WIND SPEED 10-14 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		3								
85-89		7	10							
80-84		8	10	3	2					
75-79			3	16	8					
70-74			5	2	5	3				
65-69				5	5	7	2	2		
60-64					3		5			
55-59							3			
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		18	28	26	23	10	10	2		
NUMBER	0	11	17	16	14	6	6	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94			2							
85-89		2		2						
80-84										
75-79				2						
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2	2	3						
NUMBER	0	1	1	2	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99												0
90-94											29	18
85-89											151	93
80-84											237	146
75-79											197	121
70-74											140	86
65-69											128	79
60-64											50	31
55-59											49	30
50-54											15	9
45-49											3	2
40-44												0
35-39												0
30-34												0
<30												0
TOTAL											1000	
NUMBER	0	0	0	0	0	0	0	0	0	0		615

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2	11								
85-89		29	18	2						
80-84		7	62	13	5	2				
75-79		3	13	31	8	3	2			
70-74		2	3	16	10	15	3	3		
65-69			3	16	10	8	7	2	3	
60-64				2	2	11	7	7	3	3
55-59					5	5	10	3	3	7
50-54							2	7	5	8
45-49									5	7
40-44										2
35-39										
30-34										
<30										
TOTAL	2	52	99	80	39	44	29	21	20	26
NUMBER	1	32	61	49	24	27	18	13	12	16

WIND SPEED 5-9 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2	2							
90-94		21	8							
85-89		28	34	5						
80-84		21	63	13	3					
75-79		10	29	39	7					
70-74			18	24	33	5	2			
65-69			2	10	13	11	7	2		
60-64				3	7	5	5	2	2	
55-59				3		3	2	3	3	
50-54							2	2		
45-49										3
40-44										
35-39										
30-34										
<30										
TOTAL		81	156	98	62	24	16	8	5	3
NUMBER	0	50	96	60	38	15	10	5	3	2

WIND SPEED 10-14 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94	2	2								
85-89		10	8							
80-84	2	7	18	7						
75-79		2	7	10	2					
70-74			8	10	7		2			
65-69				5	3					
60-64			2		2	2			2	
55-59							2	2		
50-54								2		
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	3	21	42	31	13	2	3	3	2	
NUMBER	2	13	26	19	8	1	2	2	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2									
85-89	2	2								
80-84		2								
75-79			2	2						
70-74						2				
65-69										
60-64					2					
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	3	3	2	2	2	2				
NUMBER	2	2	1	1	1	1	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74						2				
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL						2				
NUMBER	0	0	0	0	0	1	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	5	3
90-94	47	29
85-89	137	84
80-84	223	137
75-79	167	103
70-74	163	100
65-69	101	62
60-64	65	40
55-59	50	31
50-54	26	16
45-49	15	9
40-44	2	1
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		615

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101032 RED RIVER RS 1964-1983

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		6								
85-89		6	6							
80-84	2	9	11	7						
75-79		9	20	24	2					
70-74		4	13	33	15	7				
65-69		2	11	28	13	20	11			
60-64				15	13	15	6	6	2	
55-59			9	6	22	7	9	9	7	2
50-54		2		2	13	13	9	9	15	7
45-49				4	6	2	4	6	11	11
40-44			2			4	4	6	9	9
35-39					2				4	
30-34										
<30										
TOTAL	2	37	72	119	86	69	43	35	48	30
NUMBER	1	20	39	64	46	37	23	19	26	16

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		2								
85-89		13	7							
80-84		6	15	13	2					
75-79		6	28	13	6					
70-74		4	30	19	15	6				
65-69		2	9	28	11	4				
60-64		4		9	15	6	6			
55-59			7	6	9	7	2		2	
50-54				6	4	7		4	2	
45-49					2	6	9	2	4	
40-44					2	2	2	2		
35-39									2	
30-34										
<30										
TOTAL		35	97	93	65	37	19	7	9	
NUMBER	0	19	52	50	35	20	10	4	5	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		2								
85-89		2								
80-84		2	7							
75-79		4	4	2	2					
70-74			11	9	2					
65-69		2	2	2						
60-64			2	4	6	2				
55-59			2				4			
50-54					2	2				
45-49						4				
40-44										
35-39										
30-34										
<30										
TOTAL		11	28	17	11	7	4			
NUMBER	0	6	15	9	6	4	2	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79		2	4							
70-74			2							
65-69			2		2					
60-64				2						
55-59				2						
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2	7	4	2					
NUMBER	0	1	4	2	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69			2							
60-64										
55-59										
50-54						2				
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL			2			2				
NUMBER	0	0	1	0	0	1	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94	9	5
85-89	33	18
80-84	74	40
75-79	125	67
70-74	169	91
65-69	151	81
60-64	110	59
55-59	113	61
50-54	99	53
45-49	69	37
40-44	41	22
35-39	7	4
30-34		0
<30		0
TOTAL	1000	
NUMBER		538

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1964-1983

MONTH JUN

WIND SPEED 0-4 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		3								
95-99		5								
90-94	2	7	3	3						
85-89		12	9	10						
80-84	2	9	9	15	2					
75-79		2	7	[illegible]	9	2				
70-74		2	3	15	7	9	3			
65-69			5	3	9	5	3		2	
60-64			2	2	3	12	7	14	2	
55-59				2		5	5	3	7	
50-54						2		2	3	
45-49							2			
40-44										
35-39										
30-34										
<30										
TOTAL	3	39	37	60	29	34	20	19	14	
NUMBER	2	23	22	35	17	20	12	11	8	0

WIND SPEED 5-9 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99		7	7							
90-94	2	22	12	7						
85-89	2	14	34	9	2					
80-84		14	31	17	5					
75-79	2	10	36	14	7	3	2			
70-74		9	20	24	22	9	2			
65-69			7	20	7	9		2	2	
60-64			2	3	12	5	5	2	3	
55-59					2	5	5	9	2	
50-54						2	2	2		
45-49								2		
40-44										
35-39										
30-34										
<30										
TOTAL	7	75	148	94	56	32	15	15	7	
NUMBER	4	44	87	55	33	19	9	9	4	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	3	2								
95-99	2	5								
90-94		12	15							
85-89		17	24	3						
80-84		7	27	20	3					
75-79		2	22	9	2	2				
70-74			19	12	5	5	5			
65-69			2	2	5	5				
60-64			2	2	7	3		3		
55-59					5	2	2			
50-54					2					
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	44	111	48	29	17	7	3		
NUMBER	3	26	65	28	17	10	4	2	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		2								
95-99										
90-94	2									
85-89			2	2	2					
80-84			2							
75-79										
70-74		2	2	3	2	2	2			
65-69					3	2				
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	3	5	5	7	3	2			
NUMBER	1	2	3	3	4	2	1	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79					2					
70-74										
65-69							2			
60-64							2			
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL					2		3			
NUMBER	0	0	0	0	1	0	2	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	12	7
95-99	26	15
90-94	87	51
85-89	139	82
80-84	162	95
75-79	138	81
70-74	182	107
65-69	94	55
60-64	92	54
55-59	53	31
50-54	14	8
45-49	3	2
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		588

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	3	6								
95-99	2	27	11							
90-94		15	18	10						
85-89	2	5	13	10	3					
80-84		5	5	13	2					
75-79		2	6	3	3					
70-74			3		8		5			
65-69					5	2		3	3	
60-64							2	5		
55-59							2	2		
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	6	60	57	36	21	2	8	10	3	
NUMBER	4	37	35	22	13	1	5	6	2	0

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	8	24	2							
95-99	8	66	16							
90-94	5	45	34	11						
85-89		23	52	18	2					
80-84		5	36	18	8	2				
75-79		3	8	18	8	3				
70-74			5	5	6	8				
65-69					3	2		3		
60-64										
55-59						2				
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	21	166	152	69	27	16		3		
NUMBER	13	103	94	43	17	10	0	2	0	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	10	3								
95-99	5	23	5							
90-94		44	26	3						
85-89		23	44	10						
80-84		15	29	15	3					
75-79			11	11	5	2				
70-74			2	10	3	5	2			
65-69					2	2				
60-64										
55-59							2			
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	15	107	116	48	13	8	3			
NUMBER	9	66	72	30	8	5	2	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		5								
90-94		3	2							
85-89			3		2					
80-84			2	3	2					
75-79			3	2						
70-74				3	2					
65-69						2				
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		8	10	8	5	2				
NUMBER	0	5	6	5	3	1	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL										
NUMBER	0	0	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	57	35
95-99	168	104
90-94	215	133
85-89	207	128
80-84	160	99
75-79	89	55
70-74	66	41
65-69	26	16
60-64	6	4
55-59	6	4
50-54		0
45-49		0
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		619

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	16	23								
95-99	5	26	15							
90-94	2	31	13	2						
85-89		6	24	10		2				
80-84		5	16	8	3					
75-79			6	16	5	2				
70-74		2	2	6	5	3	3		2	
65-69			3	3	6	2	2		5	2
60-64					2	6	2	3	3	
55-59								2	3	2
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	23	92	79	45	21	15	6	5	13	3
NUMBER	14	57	49	28	13	9	4	3	8	2

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	23	18	2							
95-99	11	56	8	2						
90-94	5	66	31	3						
85-89	2	37	29	3		2				
80-84		11	37	24	2					
75-79		3	11	10	5	3				
70-74			6	15	11			2		
65-69			2	3	2					
60-64					2	2	3		2	
55-59							2			
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	40	192	126	60	21	6	5	2	2	
NUMBER	25	119	78	37	13	4	3	1	1	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	8	6								
95-99	8	26								
90-94	8	35	21							
85-89		16	13	5						
80-84		8	18	6	3					
75-79		3	6	8	3					
70-74			2	3	5	3	2			
65-69					2	2	2			
60-64				2						
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	24	95	60	24	13	5	3			
NUMBER	15	59	37	15	8	3	2	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99			2							
90-94										
85-89		2		2						
80-84			2	2	2					
75-79			3	2		2				
70-74						2				
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2	6	5	2	3				
NUMBER	0	1	4	3	1	2	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74					2					
65-69						2				
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL					2	2				
NUMBER	0	0	0	0	1	1	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	95	59
95-99	158	98
90-94	216	134
85-89	152	94
80-84	147	91
75-79	89	55
70-74	74	46
65-69	35	22
60-64	26	16
55-59	8	5
50-54		0
45-49		0
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		620

(con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101033 RIGGINS RS 1964-1983

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		2								
95-99	2	5								
90-94	2	12	7							
85-89	2	24	10	2						
80-84		21	43	9						
75-79	2	17	22	14	3		2			
70-74		7	9	22	10	3	3		3	
65-69		2	7	7	10	12	3			
60-64			5	5	9	7	3			
55-59			3	3	2	2	9	7	5	2
50-54					2	7	7		2	
45-49									2	
40-44										
35-39										
30-34										
<30										2
TOTAL	7	90	107	62	36	31	28	7	12	3
NUMBER	4	52	62	36	21	18	16	4	7	2

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2	9								
90-94		10	7							
85-89		26	22	3						
80-84	2	22	38	12						
75-79		5	33	36						
70-74	2	9	28	26	10					
65-69		2	9	17	12	5	3			
60-64			7	9	9	9	5	2	2	
55-59			2	7	2	2		3		
50-54				2			2	3		
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	83	145	112	33	16	10	9	2	
NUMBER	3	48	84	65	19	9	6	5	1	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		2								
95-99	2	5								
90-94	2	12								
85-89	2	16	9							
80-84	2	9	7	5						
75-79	2	5	17	9			2			
70-74		5	10	2	3	2				
65-69			16	7	2	2				
60-64				2	2	2				
55-59			2		2	2		2	2	
50-54			2		2					
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	9	54	62	24	10	7	2	2	2	
NUMBER	5	31	36	14	6	4	1	1	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	3		2							
80-84		2	2							
75-79		2	5							
70-74			3	2	3					
65-69				2						
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	3	3	12	3	3					
NUMBER	2	2	7	2	2	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79			2							
70-74										
65-69										
60-64			2							
55-59										
50-54				2						
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL			3	2						
NUMBER	0	0	2	1	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	3	2
95-99	24	14
90-94	52	30
85-89	121	70
80-84	173	100
75-79	178	103
70-74	164	95
65-69	117	68
60-64	78	45
55-59	57	33
50-54	29	17
45-49	2	1
40-44		0
35-39		0
30-34		0
<30	2	1
TOTAL	1000	
NUMBER		579

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101019 HELLS HALF ACRE LO 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79			9	2		2				
70-74			11	12	14	5		2		
65-69		2	14	16	23	9	2	2		
60-64				14	14	9	4	5	2	
55-59				5	16	12	5	5	2	
50-54					4	9	5	4	4	2
45-49						2	2	4	2	2
40-44								2	4	5
35-39							2			4
30-34										5
<30										2
TOTAL		2	34	49	71	48	19	23	12	19
NUMBER	0	1	19	28	40	27	11	13	7	11

WIND SPEED 5-9 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2								
75-79	2	11	16	4	4					
70-74		9	46	49	16	2				
65-69		9	32	42	32	14	4			
60-64		2	9	25	41	19	11	2		
55-59				4	12	9	12	5		
50-54					2	7	5	5	5	2
45-49				2		4	5	4		5
40-44							2	4	2	4
35-39										
30-34										
<30										
TOTAL	2	32	102	125	106	55	39	19	7	11
NUMBER	1	18	58	71	60	31	22	11	4	6

WIND SPEED 10-14 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79		2	14	4	2					
70-74		11	35	11	5					
65-69			14	7	11	2				
60-64			7	7	4	2	4	2		
55-59				5	2	2	2	2		
50-54				5	2	2		2	2	
45-49						2	2		2	
40-44								4		
35-39										
30-34										2
<30										
TOTAL		12	71	39	25	9	7	9	4	2
NUMBER	0	7	40	22	14	5	4	5	2	1

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84				2						
75-79		2	5	2						
70-74		2	4		2					
65-69			2	7						
60-64						2				
55-59						5	2			2
50-54										
45-49										
40-44									2	
35-39										
30-34										
<30										
TOTAL		4	11	11	2	7	2		2	2
NUMBER	0	2	6	6	1	4	1	0	1	1

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99												0
90-94												0
85-89												0
80-84											4	2
75-79											78	44
70-74		2	2								238	135
65-69			2								243	138
60-64			2		2						185	105
55-59											109	62
50-54											65	37
45-49										2	37	21
40-44											26	15
35-39											5	3
30-34											7	4
<30											2	1
TOTAL		2	5		2					2	1000	
NUMBER	0	1	3	0	1	0	0	0	0	1		567

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101019 HELLS HALF ACRE LO 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79		5	3	2		2				
70-74		5	16	12	9	3				
65-69		5	17	17	7	5	5			
60-64		2	3	12	21	7	3	2		
55-59			2	3	7	14	5	5	2	
50-54				3	2	3	10		2	
45-49					2	2	2	3	5	2
40-44							2	3	5	
35-39								2		3
30-34									2	7
<30										
TOTAL		17	41	50	47	36	28	16	16	12
NUMBER	0	10	24	29	27	21	16	9	9	7

WIND SPEED 5-9 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		7								
75-79	3	22	17		2					
70-74		17	52	14	2	2		2		
65-69		7	28	36	16	9	2			
60-64			14	19	19	14	5	5		
55-59			2	9	9	16	16	5	2	
50-54				3	5	12	10	3	7	
45-49				2	3	2	3		10	7
40-44						3	2		2	2
35-39									2	5
30-34										2
<30										2
TOTAL	3	53	112	83	55	57	38	16	22	17
NUMBER	2	31	65	48	32	33	22	9	13	10

WIND SPEED 10-14 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79	3	24	7	2	2					
70-74		19	31	3		2				
65-69		5	14	14	2	2				
60-64			2	12	10	5	3		2	
55-59		2			2	7	3			
50-54				2	3	5	3	2		
45-49						2	2			2
40-44					2					5
35-39								2		
30-34										
<30										2
TOTAL	3	50	53	33	21	22	12	3	2	9
NUMBER	2	29	31	19	12	13	7	2	1	5

WIND SPEED 15-19 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2	2							
75-79		3								
70-74		12	5							
65-69			5	7						
60-64				5						
55-59			3			2	2			
50-54										
45-49										
40-44								2		
35-39								2		2
30-34										2
<30										
TOTAL		17	16	12		2	2	3		3
NUMBER	0	10	9	7	0	1	1	2	0	2

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74		3	2							
65-69		2	2							
60-64			2		2					
55-59					2					
50-54										
45-49										2
40-44										
35-39										
30-34										2
<30										
TOTAL		5	5		3					3
NUMBER	0	3	3	0	2	0	0	0	0	2

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94		0
85-89		0
80-84	10	6
75-79	98	57
70-74	210	122
65-69	205	119
60-64	169	98
55-59	117	68
50-54	78	45
45-49	50	29
40-44	28	16
35-39	17	10
30-34	14	8
<30	3	2
TOTAL	1000	
NUMBER		580

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101801 BONANZA GS 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		3								
85-89	3	17	3							
80-84	2	61	17	3						
75-79	2	19	40	22	3	2				
70-74		5	15	19	8	3				
65-69		3	3	7	7	3	3			
60-64			3	2	5	2	3	3	3	
55-59					3	2	5	5	3	3
50-54						2	3	7	3	2
45-49										2
40-44										
35-39										
30-34										
<30										
TOTAL	7	108	82	52	27	13	15	15	10	7
NUMBER	4	64	49	31	16	8	9	9	6	4

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2									
85-89	2	15	7							
80-84	5	89	45	2	2					
75-79	3	52	61	30						
70-74	2	27	32	34	8	2	2			
65-69	2	8	24	12	7	8				
60-64		2	5	2	7		5	2	3	
55-59					3	5	2	2		
50-54				2	2		2			
45-49							2		2	
40-44										
35-39										
30-34										
<30										
TOTAL	15	194	173	81	29	15	12	3	5	
NUMBER	9	115	103	48	17	8	7	2	3	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		7								
80-84	3	19	5	2						
75-79		15	13							
70-74		3	12	15	2		2			
65-69			3	5	7	2	2	2		
60-64				3			2			
55-59				2			2			
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	3	44	34	27	8	2	7	2		
NUMBER	2	26	20	16	5	1	4	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		3								
75-79		2	2							
70-74					2					
65-69			2							
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		5	3		2					
NUMBER	0	3	2	0	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH; TOTAL; NUMBER

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99												0
90-94											5	3
85-89											54	32
80-84											258	153
75-79											266	158
70-74											192	114
65-69											109	65
60-64											52	31
55-59											37	22
50-54											22	13
45-49											5	3
40-44												0
35-39												0
30-34												0
<30												0
TOTAL											1000	
NUMBER	0	0	0	0	0	0	0	0	0	0		594

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101801 BONANZA GS 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94			2							
85-89	2	23	2							
80-84	2	51	26		2					
75-79	2	35	45	10	2					
70-74		13	22	8	7	2	2	2		
65-69		2	13	22	10	5	3	5		
60-64		2	3	5	7	5	5	2		
55-59			2	2	2	2	5	5	7	2
50-54					7	3	3	10	3	2
45-49			2						2	
40-44								5		2
35-39										
30-34										
<30										
TOTAL	5	126	116	46	35	17	18	28	12	5
NUMBER	3	76	70	28	21	10	11	17	7	3

WIND SPEED 5-9 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	2	12	5							
80-84	8	81	33	3			2			
75-79	2	55	61	7						
70-74		18	51	18	3	2				
65-69		12	13	17	5		3			
60-64	2		12	8	12	5		2		
55-59				7	5	7	2	2		
50-54				3	2	3	2		2	
45-49			2	2		2				2
40-44										
35-39										
30-34										
<30										
TOTAL	13	177	177	65	26	18	8	3	2	2
NUMBER	8	107	107	39	16	11	5	2	1	1

WIND SPEED 10-14 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	2	2								
80-84	3	17	3	2						
75-79	3	13	8	2						
70-74		10	12	3	2					
65-69		3	3	2						
60-64			2		2					
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	8	45	28	8	3					
NUMBER	5	27	17	5	2	0	0	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		5								
75-79										
70-74			2							
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		5	2							
NUMBER	0	3	1	0	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2								
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2								
NUMBER	0	1	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94	2	1
85-89	48	29
80-84	240	145
75-79	243	147
70-74	175	106
65-69	118	71
60-64	71	43
55-59	46	28
50-54	40	24
45-49	10	6
40-44	7	4
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		604

(con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101801 BONANZA GS 1964-1983

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84	2	9	7							
75-79	2	39	25	2						
70-74		29	29	9	2					
65-69		20	27	23	2					
60-64		11	16	9	11	5	2			
55-59		5	14	16	5	9	2	7		
50-54			7	2	9	11	2	7	5	
45-49				2	2	16	16		5	
40-44				2	5	2		7		9
35-39					2		2	7	5	2
30-34										
<30										
TOTAL	5	116	125	66	39	43	25	27	14	11
NUMBER	2	51	55	29	17	19	11	12	6	5

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84	5	16	2							
75-79	5	54	34	2						
70-74	7	48	36	11	2					
65-69		16	25	20	9					
60-64		16	20	14	9		2			
55-59		2	11	16	5	5	5	2		
50-54			9	7	2	5	2	2		
45-49				2	2	7	2			
40-44				2	2		2			
35-39							2	2	5	
30-34										
<30										
TOTAL	16	154	138	75	32	16	16	7	5	
NUMBER	7	68	61	33	14	7	7	3	2	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		5								
75-79	2	18	2	5						
70-74		7	5							
65-69		5	9							
60-64			2							
55-59							2			
50-54					2					
45-49				2						
40-44							2	2		
35-39										
30-34										
<30										
TOTAL	2	34	18	7	2		5	2		
NUMBER	1	15	8	3	1	0	2	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74		2								
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2								
NUMBER	0	1	0	0	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL										
NUMBER	0	0	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94		0
85-89	5	2
80-84	45	20
75-79	190	84
70-74	188	83
65-69	156	69
60-64	118	52
55-59	104	46
50-54	73	32
45-49	57	25
40-44	36	16
35-39	27	12
30-34		0
<30		0
TOTAL	1000	
NUMBER		441

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101207 LANDMARK RS 1964-1981

MONTH JUL

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89			2							
80-84		26	11							
75-79		19	26	2						
70-74		6	15	19	4	2				
65-69		2	9	11	8	6				
60-64			2			2	2			
55-59						2		4		
50-54								2	4	2
45-49									4	
40-44										
35-39										
30-34										
<30										
TOTAL		53	66	32	11	11	2	6	8	2
NUMBER	0	28	35	17	6	6	1	3	4	1

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		15	4		2					
80-84	2	79	45		2					
75-79	2	90	83	21						
70-74		26	86	49	11	2				
65-69		9	36	23	23	4				
60-64		6	4	28	15	6				
55-59			2	6	6		2		2	
50-54					2			2		
45-49							2	2	4	
40-44										
35-39										
30-34										
<30										
TOTAL	4	226	259	126	60	11	4	4	6	
NUMBER	2	120	138	67	32	6	2	2	3	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84		15	4							
75-79		13	21							
70-74		2	13	8						
65-69			2	8	2					
60-64			2	4	2					
55-59				6		2				
50-54										
45-49										
40-44					2					
35-39										
30-34										
<30										
TOTAL		32	41	24	6	2				
NUMBER	0	17	22	13	3	1	0	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2								
75-79										
70-74			2							
65-69				2						
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2	2	2						
NUMBER	0	1	1	1	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL										
NUMBER	0	0	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94		0
85-89	24	13
80-84	186	99
75-79	276	147
70-74	244	130
65-69	143	76
60-64	71	38
55-59	30	16
50-54	11	6
45-49	11	6
40-44	2	1
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		532

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101207 LANDMARK RS 1964-1981

MONTH AUG

WIND SPEED 0-4 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		5								
80-84	2	9	5	2						
75-79		18	7	2						
70-74		5	15	11	2					
65-69		2	7	18	7	2				
60-64				7	4	2	7			
55-59		2	2	2	2		2	7	9	
50-54					5	2		2		4
45-49						2	2	5	7	
40-44									2	5
35-39										
30-34										
<30										
TOTAL	2	42	36	42	20	7	11	15	18	9
NUMBER	1	23	20	23	11	4	6	8	10	5

WIND SPEED 5-9 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	5	4								
80-84	13	105	24							
75-79	2	78	62	5						
70-74		27	69	20						
65-69		11	53	29	11	2	2			
60-64			7	22	13	5	2			
55-59			5	7	13	4	4	2	2	
50-54			4		2	5	5	2		
45-49					4	4	11	2	2	
40-44								2	2	
35-39										
30-34										
<30										
TOTAL	20	225	223	83	42	20	24	7	5	
NUMBER	11	124	123	46	23	11	13	4	3	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		4								
80-84	2	20	5							
75-79	7	18	16							
70-74		9	15	7	2					
65-69		2	9	2						
60-64			2	9	2					
55-59				5	4	2				
50-54								2		
45-49							2			
40-44										
35-39										
30-34										
<30										
TOTAL	9	53	47	24	7	2	2	2		
NUMBER	5	29	26	13	4	1	1	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84										
75-79										
70-74		2								
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		4								
NUMBER	0	2	0	0	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	RH 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL										
NUMBER	0	0	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94		0
85-89	20	11
80-84	187	103
75-79	216	119
70-74	183	101
65-69	156	86
60-64	82	45
55-59	73	40
50-54	33	18
45-49	40	22
40-44	11	6
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		551

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101207 LANDMARK RS 1964-1981

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		4	2							
75-79		12	4	2						
70-74		14	21	2						
65-69		4	14	12	6					
60-64		4	14	6	12	2	4			
55-59			8	10	8		6			
50-54			6	6	8	2	4	6	2	
45-49				2	2		8	8	12	
40-44				2		2	2	14	10	8
35-39									4	4
30-34										
<30										
TOTAL		39	70	43	37	6	25	29	29	12
NUMBER	0	19	34	21	18	3	12	14	14	6

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84	2	12	2	2						
75-79		29	19	4						
70-74		62	56	14						
65-69		23	49	21	4	2				
60-64		10	31	14	10	2	2			
55-59		16	19	27	14	2	2	2		
50-54			12	16	4	10	6	4	2	2
45-49			2	4	10	12	2	4	4	
40-44				4	2	2	4	10	2	2
35-39							4	6	2	4
30-34				2				2	2	2
<30										
TOTAL	2	152	189	109	45	31	21	29	12	10
NUMBER	1	74	92	53	22	15	10	14	6	5

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		4								
75-79	4	4	2							
70-74		10	12							
65-69			10	6						
60-64		2	8	8						
55-59		2	6	4		4				
50-54				6			2	2	2	
45-49										
40-44					2					
35-39							2			
30-34										
<30							2			
TOTAL	4	23	39	25	2	4	6	2	2	
NUMBER	2	11	19	12	1	2	3	1	1	0

WIND SPEED 15-19 MPH / WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	15-19: 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	≥20: 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100																						0
95-99																						0
90-94																						0
85-89																						0
80-84																					29	14
75-79																					80	39
70-74																					191	93
65-69																					152	74
60-64			2																		134	65
55-59																					132	64
50-54																					105	51
45-49																					72	35
40-44																					68	33
35-39																					27	13
30-34																					8	4
<30																					2	1
TOTAL			2																		1000	
NUMBER	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		486

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101803 CHALLIS RS 1964-1983

MONTH JUN

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	2	6	10							
80-84		30	18							
75-79	4	20	26	6	2					
70-74		14	18	12	8	4	2			
65-69		4	22	10	6	6	2			
60-64			8	14	18	8	4	2		
55-59		2	4	4	2	6	12		2	
50-54			2		2	2	4	4		4
45-49							2	2		
40-44										
35-39										
30-34										
<30										
TOTAL	6	75	107	46	38	26	26	8	2	4
NUMBER	3	38	54	23	19	13	13	4	1	2

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		18	2							
85-89		32								
80-84	6	18	12	2						
75-79	4	32	36	10						
70-74		28	34	6	2					
65-69		10	32	20	6	2	2			
60-64		6	16	22	4	8				
55-59			10	8	6	12	6	6		2
50-54			2	2	2	2	2		2	
45-49									6	
40-44									2	
35-39										
30-34										
<30										
TOTAL	10	143	143	69	20	24	10	6	10	2
NUMBER	5	72	72	35	10	12	5	3	5	1

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		4								
85-89	4	8	2							
80-84	4	14	2	2						
75-79	2	12	10	4						
70-74		12	10	8						
65-69		4	8	4	2	2				
60-64		6	4	4	6					
55-59			4	4		2	2			
50-54		2			4					
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	10	61	40	26	12	4	2			
NUMBER	5	31	20	13	6	2	1	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		8								
80-84	4	18	2							
75-79	2	4	2	2						
70-74		2		6						
65-69										
60-64										
55-59					2	2				
50-54				2						
45-49				2			2			
40-44										
35-39										
30-34										
<30										
TOTAL	6	32	4	12	2	2	2			
NUMBER	3	16	2	6	1	1	1	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79	2	6								
70-74										
65-69										
60-64					2					
55-59					2				2	
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	6			4				2	
NUMBER	1	3	0	0	2	0	0	0	1	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94	24	12
85-89	71	36
80-84	131	66
75-79	184	93
70-74	164	83
65-69	141	71
60-64	131	66
55-59	101	51
50-54	38	19
45-49	14	7
40-44	2	1
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		505

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101803 CHALLIS RS 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2	17								
85-89	10	46	15	7	2					
80-84	2	31	35	15	3					
75-79		17	26	18	12	2	2			
70-74		3	10	5	10	3	3			
65-69		2		5	3	2	2	2		
60-64				2		3	2		2	
55-59						3		2		
50-54								2		
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	13	116	86	51	30	13	8	5	2	
NUMBER	8	70	52	31	18	8	5	3	1	0

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2									
90-94	22	28								
85-89	15	79	23							
80-84	5	76	41	8						
75-79	3	23	15	7		2				
70-74		2	22	5	10	3				
65-69			2	3	3					
60-64			2		3	2				
55-59					2	3	2	2		2
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	46	209	104	23	18	10	2	2		2
NUMBER	28	126	63	14	11	6	1	1	0	1

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94	20	12								
85-89	3	38	12	2						
80-84	7	30	18		3					
75-79		12	8	2						
70-74	2	2	2	2		2				
65-69			2	5	2					
60-64			2		2	2				
55-59					2					
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	31	94	43	10	8	3				
NUMBER	19	57	26	6	5	2	0	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94	3	8								
85-89	5	7	2							
80-84		10								
75-79			7	2						
70-74		2	2		2	2				
65-69			2	2						
60-64							2			
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	8	28	12	3	2	2	2			
NUMBER	5	17	7	2	1	1	1	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99											5	3
90-94	2										113	68
85-89	2	2									268	162
80-84	2	2									288	174
75-79											156	94
70-74			2								93	56
65-69											35	21
60-64						2					23	14
55-59					2						18	11
50-54											2	1
45-49												0
40-44												0
35-39												0
30-34												0
<30												0
TOTAL	5	3	2		2	2					1000	
NUMBER	3	2	1	0	1	1	0	0	0	0		604

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101803 CHALLIS RS 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	6	16								
85-89	2	66	11	3						
80-84	3	71	24	5	5	2	2			
75-79		18	44	13	8	2				
70-74	2	3	21	11	6	3				
65-69		5	3	11	6	5	3	2	2	
60-64			5	3	5	5	3	2		
55-59				3		2	3		2	
50-54					2				2	
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	13	180	108	50	32	18	11	3	5	
NUMBER	8	111	67	31	20	11	7	2	3	0

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	13	13	2							
85-89	19	65	10		2					
80-84	5	55	26	10						
75-79	2	26	19	10	3					
70-74		13	11	10	8	2				
65-69		2	11	2	3		2	2	2	
60-64		2	3	6	5	3	2	2		
55-59				5	2	3				
50-54						5				
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	39	175	83	42	23	13	3	3	2	
NUMBER	24	108	51	26	14	8	2	2	1	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94	8	13								
85-89	13	31								
80-84	5	19	5	5						
75-79		6	2	5						
70-74			6		5		2			
65-69		2	3	3	3					
60-64			2	2						
55-59				2	2					
50-54				2		3			2	
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	26	73	18	18	10	3	2		2	
NUMBER	16	45	11	11	6	2	1	0	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2									
90-94	3	2								
85-89	3	10	2							
80-84		2								
75-79		2	3	3						
70-74		2		2						
65-69		3	2							
60-64										
55-59					2					
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	8	19	6	5	2					
NUMBER	5	12	4	3	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99											3	2
90-94	2										78	48
85-89	2										238	147
80-84				2							244	151
75-79		2									167	103
70-74											107	66
65-69											76	47
60-64											49	30
55-59											24	15
50-54											15	9
45-49												0
40-44												0
35-39												0
30-34												0
<30												0
TOTAL	3	2		2							1000	
NUMBER	2	1	0	1	0	0	0	0	0	0		618

(con.)

Table 28 (Con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101803 CHALLIS RS 1964-1983

MONTH SEP

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	2	5								
80-84	5	27	5							
75-79	2	66	34	2						
70-74	2	37	44	12	2					
65-69		15	39	19	5		3			
60-64		19	19	19	8	5	2	2		
55-59		5	10	12	12	3	7	3	2	
50-54			5	5	7	5	3			
45-49			2	5			2			
40-44					2	2	2			
35-39										
30-34										
<30										
TOTAL	10	175	158	73	36	15	19	5	2	
NUMBER	6	103	93	43	21	9	11	3	1	0

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		7	3							
80-84		41	2							
75-79	3	25	14							
70-74	2	20	37	5						
65-69		17	19	10	2					
60-64		10	3	15	5					
55-59		2	14	12	12	2				
50-54			3	3	7	3	3			
45-49			3	2	3	2	5			
40-44				3				2	2	
35-39									2	
30-34										
<30										
TOTAL	5	122	98	51	29	7	8	2	3	
NUMBER	3	72	58	30	17	4	5	1	2	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		2								
85-89	2	14								
80-84	3	7	5							
75-79		14	10							
70-74		7	17	2						
65-69		3	3	5	3					
60-64		2	5	2		3				
55-59			2		2	2				
50-54				5		2	2			
45-49					3					
40-44						3				
35-39										
30-34										
<30										
TOTAL	5	48	42	14	8	10	2			
NUMBER	3	28	25	8	5	6	1	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84		7								
75-79	2	3	5							
70-74		2	2	2						
65-69	2		3							
60-64		2			2					
55-59				2	2		2			
50-54				3						
45-49				2						
40-44								2		
35-39					2					
30-34										
<30										
TOTAL	3	15	10	8	5		2	2		
NUMBER	2	9	6	5	3	0	1	1	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2								
75-79										
70-74		3	2							
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		5	2							
NUMBER	0	3	1	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94	2	1
85-89	34	20
80-84	104	61
75-79	180	106
70-74	197	116
65-69	149	88
60-64	122	72
55-59	105	62
50-54	58	34
45-49	29	17
40-44	17	10
35-39	3	2
30-34		0
<30		0
TOTAL	1000	
NUMBER		589

(con.)

Table 28 (Con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101303 INDIANOLA RS 1964-1983

MONTH JUN

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2	5	3							
85-89		10	9	3						
80-84		16	33	16	5					
75-79	2	7	31	9	3					
70-74		5	19	19	9	3	3			
65-69			12	10	14	5		2		
60-64				5	14	7	5	3		2
55-59				3	3	5	10	5	9	
50-54						3	2	3	7	2
45-49							2		2	
40-44										
35-39										
30-34										
<30										
TOTAL	3	43	107	66	48	24	22	14	17	3
NUMBER	2	25	62	38	28	14	13	8	10	2

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		7								
90-94	2	9	7							
85-89	2	28	31							
80-84	2	35	42	12	5					
75-79		19	22	17	14	2				
70-74		9	19	19	9	2	2	2		
65-69		3	14	22	14	5	3	2		
60-64			3	7	3	12	5		3	
55-59		2		5	3	3	3			
50-54					2			5	2	
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	111	138	83	50	24	14	9	5	
NUMBER	3	64	80	48	29	14	8	5	3	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2	2								
90-94		10	9							
85-89		9	7							
80-84		9	9							
75-79	2	3	14	7	2					
70-74		7	9	5	2					
65-69			2	2		2	2			
60-64				3	3	3				
55-59				5	2	3	5			
50-54					3	2		2		
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	3	40	48	22	12	10	7	2		
NUMBER	2	23	28	13	7	6	4	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94		3	2							
85-89		3	3							
80-84		9	5							
75-79		5	3	2						
70-74			2							
65-69				2			2			
60-64				3						
55-59				2		2	2	2		
50-54						2				
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		22	16	9		3	3	2		
NUMBER	0	13	9	5	0	2	2	1	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	2	3								
80-84										
75-79			2							
70-74										
65-69										
60-64										
55-59								2		
50-54										
45-49						2				
40-44										
35-39										
30-34										
<30										
TOTAL	2	3	2			2		2		
NUMBER	1	2	1	0	0	1	0	1	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	12	7
90-94	52	30
85-89	111	64
80-84	196	113
75-79	166	96
70-74	144	83
65-69	118	68
60-64	85	49
55-59	78	45
50-54	35	20
45-49	5	3
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		578

(con.)

Table 28 (Con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101303 INDIANOLA RS 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99		12	5							
90-94		36	23	2						
85-89	2	26	31	16	2					
80-84		13	16	33	3					
75-79		5	8	2	8	3				
70-74				3	5	3				2
65-69			2		2	2				
60-64			2		3	2	3	3		3
55-59							3		3	3
50-54				2				2	3	
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	3	92	87	58	23	10	7	5	7	8
NUMBER	2	56	53	35	14	6	4	3	4	5

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99	15	30	3							
90-94	20	90	41	2						
85-89	3	67	46	15	2					
80-84		23	35	18	5					
75-79	2	7	26	16	8	3	3			
70-74		3	7	2	8	8				
65-69				3	2	2	2		3	
60-64							3		3	
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	41	220	158	56	25	13	8		7	
NUMBER	25	134	96	34	15	8	5	0	4	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99	13	5								
90-94	15	28	8		2					
85-89	2	15	7	8	2					
80-84		5	10	2	5					
75-79		5	2							
70-74				2	2					
65-69				2	2					
60-64										
55-59					2					
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	31	58	26	13	13					
NUMBER	19	35	16	8	8	0	0	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	7	2								
90-94	2	2								
85-89		7	3							
80-84										
75-79			2							
70-74			2							
65-69				2						
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	8	10	7	2						
NUMBER	5	6	4	1	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2									
85-89		2								
80-84										
75-79				2						
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	2		2						
NUMBER	1	1	0	1	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	5	3
95-99	90	55
90-94	271	165
85-89	255	155
80-84	168	102
75-79	102	62
70-74	46	28
65-69	21	13
60-64	23	14
55-59	12	7
50-54	7	4
45-49		0
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		608

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101303 INDIANOLA RS 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	7	15	3							
90-94	5	59	10	3						
85-89	2	36	41	7	3	2				
80-84		3	39	26	7	2	2			
75-79	2	5	8	15	15	2			2	
70-74		2	3	7	3	5		2		
65-69				5	7	8	3	2	2	3
60-64				2	5	5	3	3	3	3
55-59						2	5	2	2	
50-54										
45-49										2
40-44										
35-39										
30-34										
<30										
TOTAL	15	119	104	64	39	24	13	8	8	8
NUMBER	9	73	64	39	24	15	8	5	5	5

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	23	28								
90-94	16	77	2							
85-89	3	64	49	10	2					
80-84	2	15	41	20	7					
75-79		2	15	18	10					
70-74			5	13	11	3	5			
65-69		2		2	2	5	2	5		
60-64		2	2	3	5	3	2	2	2	2
55-59						2				
50-54									2	
45-49								2		
40-44										
35-39										
30-34										
<30										
TOTAL	44	187	112	65	36	13	8	8	3	2
NUMBER	27	115	69	40	22	8	5	5	2	1

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	5	2								
90-94	3	13	2							
85-89	3	11	3	2						
80-84		8	10	3						
75-79		3	3	3	2					
70-74				2	2	3				
65-69		2					2			
60-64					3	2			2	
55-59					2					
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	11	39	18	10	8	5	2		2	
NUMBER	7	24	11	6	5	3	1	0	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99	5									
90-94	2	2								
85-89	2	2								
80-84										
75-79		2		2						
70-74			2							
65-69										
60-64										
55-59							2			
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	10	5	2	2			2			
NUMBER	6	3	1	1	0	0	1	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2	2								
85-89		2								
80-84										
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	3								
NUMBER	1	2	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	2	1
95-99	86	53
90-94	195	120
85-89	241	148
80-84	182	112
75-79	106	65
70-74	67	41
65-69	49	30
60-64	52	32
55-59	15	9
50-54	2	1
45-49	3	2
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		614

(con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101303   INDIANOLA RS   1964-1983

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2									
90-94		2								
85-89		32	8							
80-84	2	17	27	5	3					
75-79		7	25	20	7					
70-74		5	27	27	12	3	5			
65-69		3	10	15	7	5	3	3		
60-64		3	3	20	12	10	12	3	3	
55-59	2	2	3	2	17	8	3	3	3	2
50-54			3	5	7	3	8	3	2	
45-49			2	2	2		2	5		
40-44									2	
35-39										
30-34										
<30										
TOTAL	5	71	110	96	66	30	34	19	10	2
NUMBER	3	42	65	57	39	18	20	11	6	1

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2	10								
85-89		25	12							
80-84	5	42	39	10	3					
75-79	2	20	36	8	2					
70-74		14	22	27	8					
65-69		7	19	20	10	7				
60-64			12	19	17	5		2		
55-59			7	3	7	7	5	2		2
50-54				5	5		2	2		2
45-49				2	2	2	2		2	
40-44					2	2				
35-39										
30-34										
<30										
TOTAL	8	118	146	95	56	22	8	5	2	3
NUMBER	5	70	86	56	33	13	5	3	1	2

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		2								
85-89		3								
80-84		5		3						
75-79		5	14	2						
70-74	2	2	7	2	2	2				
65-69	2		3	2		2				
60-64		2	2			2				
55-59			2	2	5		2			
50-54				2		2				
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	3	19	27	12	7	7	2			
NUMBER	2	11	16	7	4	4	1	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84										
75-79		3								
70-74										
65-69				2						
60-64				2	2					
55-59		2								
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		7		3	2					
NUMBER	0	4	0	2	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2								
75-79										
70-74										
65-69										
60-64										
55-59								2		
50-54										
45-49										
40-44									2	
35-39										
30-34										
<30										
TOTAL		2						2	2	
NUMBER	0	1	0	0	0	0	0	1	1	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	2	1
90-94	15	9
85-89	83	49
80-84	164	97
75-79	151	89
70-74	166	98
65-69	120	71
60-64	130	77
55-59	91	54
50-54	51	30
45-49	20	12
40-44	7	4
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		591

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101206 KRASSEL RS 1964-1983

MONTH JUN

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		5	2							
85-89		12	7	2						
80-84		12	28							
75-79		14	21	21	5					
70-74		5	16	14	9	2				
65-69			9	28	16	5	2			
60-64				2	5	21		2	9	2
55-59			2	5	12	7	7	5	14	7
50-54				2	5		7	5	9	5
45-49							5	2	5	
40-44									5	2
35-39										
30-34										
<30										
TOTAL		46	86	74	51	35	21	14	42	16
NUMBER	0	20	37	32	22	15	9	6	18	7

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		7								
90-94		19	5							
85-89	5	32	14							
80-84		49	46	16	2					
75-79		35	49	16	2					
70-74		21	35	9	2					
65-69		9	23	21	2	5	2	2		
60-64		2	14	5	5	7	2		2	
55-59			5	7	12	5	2			
50-54				7	5	2	5	5		
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	174	190	81	30	19	12	7	2	
NUMBER	2	75	82	35	13	8	5	3	1	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94	2	7								
85-89	2	7	5							
80-84		12	5							
75-79		7	2							
70-74		14	5	2	5					
65-69			5		2					
60-64			2							
55-59			2							
50-54					2					
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	46	26	2	9					
NUMBER	2	20	11	1	4	0	0	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2								
75-79										
70-74										
65-69										
60-64				2						
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2		2						
NUMBER	0	1	0	1	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69										
60-64		2								
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		2								
NUMBER	0	1	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	7	3
90-94	39	17
85-89	86	37
80-84	172	74
75-79	172	74
70-74	139	60
65-69	132	57
60-64	86	37
55-59	90	39
50-54	58	25
45-49	12	5
40-44	7	3
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		431

(con.)

Table 28 (Con.)

T E M P E R A T U R E - R E L A T I V E   H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101206 KRASSEL RS 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		2								
95-99		2								
90-94	3	20	10							
85-89	2	7	23	2	2					
80-84		18	13	15	2					
75-79			5	7	2					
70-74			5	3	3	5	3			
65-69		5	3			5	2	2	2	2
60-64			2		2	2	5	3	2	2
55-59										3
50-54									7	2
45-49										2
40-44										
35-39										
30-34										
<30										
TOTAL	5	54	62	27	10	12	10	5	10	10
NUMBER	3	32	37	16	6	7	6	3	6	6

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	20	37	3							
90-94	8	134	13							
85-89	7	82	45	2						
80-84	3	59	42	10	3					
75-79	3	20	34	3	8					
70-74		3	10	5	3	2				
65-69			3	3	2	2				
60-64			2	2	3			2	2	
55-59					2					
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	42	335	152	25	22	3		2	2	
NUMBER	25	200	91	15	13	2	0	1	1	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	2									
95-99	7	5								
90-94	13	40	2							
85-89	12	27	7	3						
80-84	2	25	8	2						
75-79		8	10							
70-74		2	7	5	2					
65-69										
60-64										
55-59					2	2				
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	35	107	34	10	3	2				
NUMBER	21	64	20	6	2	1	0	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2	2								
90-94		2								
85-89			2							
80-84		5								
75-79		2	2							
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	10	3							
NUMBER	1	6	2	0	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84		2	2							
75-79										
70-74				2						
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		3	2	2						
NUMBER	0	2	1	1	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100	3	2
95-99	77	46
90-94	246	147
85-89	223	133
80-84	211	126
75-79	104	62
70-74	60	36
65-69	30	18
60-64	27	16
55-59	8	5
50-54	8	5
45-49	2	1
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		597

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101206 KRASSEL RS 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	7	2								
90-94	7	15	5							
85-89	2	30	13	3						
80-84	3	10	7	13	2					
75-79		5	10	7	2	3	2			
70-74		2	2	7	7	2	2			
65-69			2	7	2	3		2	3	
60-64						2	3		5	2
55-59					2	2	2	5	2	3
50-54							3	5	3	2
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	18	62	38	36	13	11	11	11	13	7
NUMBER	11	38	23	22	8	7	7	7	8	M

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100	5									
95-99	21	20	2							
90-94	41	85	7							
85-89	13	98	15	3	2					
80-84		43	46	8						
75-79		15	20	13	5	2				
70-74	2	7	16	16	3	2				
65-69		3	5	8	3	3	3			
60-64			3	7	2	3		2		
55-59				2	3	2				
50-54							3	2		
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	82	270	113	57	18	11	7	3		
NUMBER	50	165	69	35	11	7	4	2	0	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100		2								
95-99	3	8								
90-94	18	31								
85-89	8	28	5							
80-84		30	13	2						
75-79		10	8	2	3					
70-74		2	8	2	2					
65-69		3		3	2					
60-64			2			2			2	
55-59					2	2				
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	30	113	36	8	8	3			2	
NUMBER	18	69	22	5	5	2	0	0	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2									
90-94		2								
85-89	3	2								
80-84		2								
75-79			2							
70-74		2								
65-69				2						
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	7	2	2						
NUMBER	3	4	1	1	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100											7	4
95-99											64	39
90-94											210	128
85-89		2									226	138
80-84											177	108
75-79											107	65
70-74											80	49
65-69											54	33
60-64											33	20
55-59											25	15
50-54											18	11
45-49												0
40-44												0
35-39												0
30-34												0
<30												0
TOTAL		2									1000	
NUMBER	0	1	0	0	0	0	0	0	0	0		610

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101206 KRASSEL RS 1964-1983

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		4								
85-89	4	16								
80-84		14	22	4						
75-79	2	8	20	10	2	2				
70-74		10	16	39	4	2				
65-69		2	10	18	12	2	2			
60-64		2	10	20	8	4		4	6	
55-59			12	6	16	8		6	4	2
50-54					4		4	14	8	6
45-49				2	4	2	2	4	4	4
40-44								4	2	
35-39										
30-34										
<30										
TOTAL	6	57	92	100	51	20	8	33	24	12
NUMBER	3	28	45	49	25	10	4	16	12	6

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94	4	8								
85-89	2	35	4							
80-84		86	16	2						
75-79		20	35	10	2					
70-74		20	24	8						
65-69	2	6	18	14	2	6				
60-64		6	20	6	10	4	2			
55-59				16	16	2	2	2		
50-54				6	6	4			2	
45-49					2		2		2	
40-44								4		2
35-39										
30-34										
<30										
TOTAL	8	184	118	63	39	16	6	6	4	2
NUMBER	4	90	58	31	19	8	3	3	2	1

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		2								
85-89	6	12								
80-84		16	4							
75-79		10	14	4						
70-74		10	8	4						
65-69		4	4	2						
60-64		2		2		2				
55-59				6						
50-54									4	
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	6	57	31	18		2			4	
NUMBER	3	28	15	9	0	1	0	0	2	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89	2	6	2							
80-84		6								
75-79		2	4							
70-74			2							
65-69				2	2					
60-64										
55-59										
50-54					2					
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	14	8	2	4					
NUMBER	1	7	4	1	2	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL										
NUMBER	0	0	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	2	1
90-94	18	9
85-89	90	44
80-84	171	84
75-79	147	72
70-74	149	73
65-69	110	54
60-64	110	54
55-59	100	49
50-54	61	30
45-49	29	14
40-44	12	6
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		490

(con.)

Table 28 (Con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101805 LITTLE CREEK GS 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	5	5	2							
90-94	2	48	13							
85-89	3	38	21	7						
80-84	2	3	31	30	3					
75-79		3	15	21	8	2				
70-74			5	3	2	2	2			
65-69			2	2	3			5	2	
60-64						2	7	2		
55-59						2		2		
50-54									2	2
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	12	97	89	63	17	7	8	8	3	2
NUMBER	7	59	54	38	10	4	5	5	2	1

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2	5	2							
90-94	7	51	10							
85-89	8	48	26							
80-84	3	21	25	12		2				
75-79		15	15	3						
70-74		5	10	5		3	2			
65-69				2		5	2	2		
60-64				2	3		3	3	2	
55-59						2	3			
50-54								2		
45-49								2		
40-44										
35-39										
30-34										
<30										
TOTAL	20	145	87	23	3	12	10	8	2	
NUMBER	12	88	53	14	2	7	6	5	1	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	5	3	2							
90-94	12	46	7							
85-89	8	46	15							
80-84		31	26	2	3					
75-79		5	15							
70-74		8	3	5	2	2	2			
65-69				2						
60-64										
55-59				2				2		
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	25	140	68	10	5	2	2	2		
NUMBER	15	85	41	6	3	1	1	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2	2								
90-94	7	7	3							
85-89	3	23	5							
80-84		12	5	3						
75-79		8	3							
70-74		3	5	2		3				
65-69			2							
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	12	54	23	5		3				
NUMBER	7	33	14	3	0	2	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94		12								
85-89	2	7	2							
80-84		3	2							
75-79		2	2							
70-74						2				
65-69				2						
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	2	25	5	2		2				
NUMBER	1	15	3	1	0	1	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	35	21
90-94	223	135
85-89	262	159
80-84	219	133
75-79	117	71
70-74	74	45
65-69	28	17
60-64	23	14
55-59	12	7
50-54	5	3
45-49	2	1
40-44		0
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		606

(con.)

Table 28 (Con.)

T E M P E R A T U R E - R E L A T I V E H U M I D I T Y - W I N D S P E E D
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101805 LITTLE CREEK GS 1964-1983

MONTH JUN

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		2	2							
85-89		14	10	4						
80-84	2	14	18	6						
75-79		10	29	16	6	2				
70-74		4	14	20	10	6				
65-69			6	14	14	8			2	
60-64				6	12	6	2	8		
55-59				4	10	6	4		2	
50-54						4	4	6	6	4
45-49							2	4	2	
40-44							2			
35-39										
30-34										
<30										
TOTAL	2	45	80	72	53	33	14	18	12	4
NUMBER	1	22	39	35	26	16	7	9	6	2

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94	2	8								
85-89	4	16	14							
80-84	2	22	14	4						
75-79		29	37	6	6					
70-74		18	14	20	2	2				
65-69		12	12	14	10					
60-64		2	4	6	4	8		2		
55-59			4	8	4		6			
50-54					4	2	4	2		
45-49					2		4		2	
40-44										
35-39										
30-34										
<30										
TOTAL	8	110	100	59	33	12	14	4	2	
NUMBER	4	54	49	29	16	6	7	2	1	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	2									
90-94	4	10								
85-89	4	14	4							
80-84	2	18	14	2						
75-79	4	10	20	6						
70-74		8	16	10						
65-69			6	10	8		2			
60-64		2	6	12	2	4	2			
55-59			4	4	8					
50-54			2	2	2					
45-49										
40-44							2			
35-39										
30-34										
<30										
TOTAL	16	63	74	47	20	4	6			
NUMBER	8	31	36	23	10	2	3	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		4								
90-94		4								
85-89		6		2						
80-84		4	6							
75-79			8	2						
70-74		2	6	2						
65-69			4	6						
60-64			2	2	2					
55-59					2	2				
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		20	27	14	4	2				
NUMBER	0	10	13	7	2	1	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		4								
85-89										
80-84		2	2							
75-79		2	4							
70-74		4			2					
65-69				2						
60-64										
55-59					2					
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		12	6	2	4					
NUMBER	0	6	3	1	2	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	8	4
90-94	37	18
85-89	94	46
80-84	135	66
75-79	198	97
70-74	164	80
65-69	133	65
60-64	96	47
55-59	72	35
50-54	43	21
45-49	16	8
40-44	4	2
35-39		0
30-34		0
<30		0
TOTAL	1000	
NUMBER		489

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101805 LITTLE CREEK GS 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94	3	50	10							
85-89	10	35	10	2	3					
80-84		13	35	5	5	2				
75-79		5	23	18	7	2				
70-74		3	12	17	8		3			
65-69			5	2	8	8		2	2	
60-64			2	3	3	3		3		3
55-59						5	3	3	5	5
50-54						2	3		2	
45-49								2		
40-44										
35-39										
30-34										
<30										
TOTAL	13	107	96	46	35	21	10	10	8	8
NUMBER	8	65	58	28	21	13	6	6	5	5

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	5	5								
90-94	20	35	5							
85-89	7	55	12							
80-84		38	15	2						
75-79	2	12	13	15	7					
70-74	2	3	10	8	7	5		2		
65-69		3	12	5	5	3	2			
60-64			3	2	8	2	2	2		
55-59					2	3		2	2	
50-54						2	2			
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	35	150	69	31	28	15	5	5	2	
NUMBER	21	91	42	19	17	9	3	3	1	0

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	7	2								
90-94	17	17								
85-89	5	23								
80-84	2	20	5	5						
75-79		5	12							
70-74			7	2	3					
65-69				2	2					
60-64				2		2				
55-59							2			
50-54								2		
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	30	66	23	10	5	2	2	2		
NUMBER	18	40	14	6	3	1	1	1	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99	3									
90-94	8	10								
85-89	8	8	3							
80-84	2	18	7		2					
75-79	2	8	3	3						
70-74		3	2		3					
65-69		2		5	2					
60-64				2				2		
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	23	50	15	10	7			2		
NUMBER	14	30	9	6	4	0	0	1	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99	5										28	17
90-94	7	7									187	113
85-89	10	7	2								198	120
80-84	3	10	5								192	116
75-79			5								140	85
70-74											99	60
65-69											68	41
60-64											43	26
55-59											31	19
50-54											12	7
45-49											2	1
40-44												0
35-39												0
30-34												0
<30												0
TOTAL	25	23	12								1000	
NUMBER	15	14	7	0	0	0	0	0	0	0		605

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101805 LITTLE CREEK GS 1964-1983

MONTH SEP

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		14	6							
80-84		37	25							
75-79	2	41	45	4						
70-74		23	45	20	4	2				
65-69		10	25	31	10	6	4			
60-64			20	25	10	2	8	2		
55-59			4	20	12	2	8	6		
50-54			2	8	4	8	2	10	2	2
45-49				2		4	6	6	2	2
40-44								2	2	4
35-39										
30-34										
<30										
TOTAL	2	125	172	111	41	25	29	27	6	8
NUMBER	1	61	84	54	20	12	14	13	3	4

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		4								
85-89		12	6							
80-84	6	27	16	2						
75-79		14	20	4	2					
70-74		4	14	2	2					
65-69		14	6	6	4	2				
60-64			14	8	10	4	8			
55-59			6	4	8	2	2			
50-54				2	2	2	4	4	4	
45-49				2	2		2			
40-44									2	
35-39										
30-34										
<30										
TOTAL	6	76	84	31	31	10	16	4	6	
NUMBER	3	37	41	15	15	5	8	2	3	0

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		2								
85-89	2	12	2							
80-84	2	14	8							
75-79		18	18	4						
70-74		2	8	8						
65-69		2	8	6						
60-64		2	2	2	2			4		
55-59						4	4		2	
50-54					2	2	2			2
45-49					2	2				
40-44										
35-39							2			
30-34										
<30										
TOTAL	4	53	47	20	6	8	8	4	2	2
NUMBER	2	26	23	10	3	4	4	2	1	1

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		4								
80-84	2	2								
75-79		2	2							
70-74		4	2	2						
65-69			2							
60-64			2	2						
55-59										
50-54										
45-49									2	
40-44										
35-39										
30-34										
<30										
TOTAL	2	12	8	4					2	
NUMBER	1	6	4	2	0	0	0	0	1	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79		2								
70-74		2								
65-69										
60-64										
55-59						2				
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		4				2				
NUMBER	0	2	0	0	0	1	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94	6	3
85-89	59	29
80-84	141	69
75-79	180	88
70-74	145	71
65-69	137	67
60-64	129	63
55-59	88	43
50-54	66	32
45-49	35	17
40-44	10	5
35-39	2	1
30-34		0
<30		0
TOTAL	1000	
NUMBER		488

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101209 MC CALL SO 1964-1983

MONTH JUN

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89			8							
80-84		4	23	6						
75-79		4	15	17	4					
70-74	2	4	25	36	13	8				
65-69	2	8	13	26	13	6	4			
60-64		2	2	13	9	8	8	4	4	
55-59			2	4	4	15	8	4	4	
50-54				2		9	6	6	8	9
45-49						2	6		11	6
40-44							2	4	2	6
35-39										2
30-34										
<30										
TOTAL	4	21	87	104	43	47	32	17	28	23
NUMBER	2	11	46	55	23	25	17	9	15	12

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89			8	2						
80-84		4	17	2						
75-79		6	32	17	6	2				
70-74		4	32	26	8	8	2			
65-69	2	2	15	26	23	13	2			
60-64			8	19	23	9	6	2	8	
55-59			9	11	11	17	2	8		
50-54				4	6	6	4	11	2	8
45-49				2	2	4		8	2	8
40-44								4	2	4
35-39										
30-34										
<30										
TOTAL	2	15	121	109	77	58	15	32	13	19
NUMBER	1	8	64	58	41	31	8	17	7	10

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2	2	2						
80-84			6							
75-79		2	6	2	2					
70-74			8	8	2	2				
65-69		2		4	8	2				
60-64			6		4	4				
55-59				8	13		2			
50-54				4	6	2	2		2	2
45-49						4	2			
40-44						2				
35-39										
30-34										
<30										
TOTAL		6	26	26	34	15	6		2	2
NUMBER	0	3	14	14	18	8	3	0	1	1

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79			2							
70-74			2	4						
65-69					2					
60-64					2					
55-59										
50-54			2							
45-49										
40-44						2				
35-39										
30-34										
<30										
TOTAL			6	4	4	2				
NUMBER	0	0	3	2	2	1	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH, and TOTAL / NUMBER

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99												0
90-94												0
85-89											23	12
80-84											60	32
75-79											115	61
70-74											191	101
65-69											172	91
60-64											138	73
55-59											121	64
50-54											98	52
45-49											55	29
40-44											26	14
35-39											2	1
30-34												0
<30												0
TOTAL											1000	
NUMBER	0	0	0	0	0	0	0	0	0	0		530

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101209 MC CALL SO 1964-1983

MONTH JUL

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		3	3							
85-89	2	30	32	8						
80-84	2	20	62	20	2					
75-79		3	37	35	22	5				
70-74	2	3	25	18	13	8	3			
65-69			7	12	5	5		3		
60-64			5		2	2	2	2	2	
55-59						2		3	2	3
50-54					2	2			5	
45-49									2	
40-44										
35-39										
30-34										
<30										13
TOTAL	5	61	171	94	45	24	5	8	10	17
NUMBER	3	36	102	56	27	14	3	5	6	10

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		3								
85-89	2	30	17	8	2					
80-84	3	20	54	24	5					
75-79		13	30	50	13					
70-74		3	17	25	17	7	2			
65-69			3	5	12	5	2			
60-64				5	10	2	5			
55-59				3	2	5	2			
50-54									3	2
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL	5	71	121	121	61	18	10		3	2
NUMBER	3	42	72	72	36	11	6	0	2	1

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		8	3							
80-84		10	22	3						
75-79		2	13	15	3					
70-74			5	12	7	3				
65-69			2	10	2					
60-64					3	3				
55-59				2			2			
50-54										
45-49						2				
40-44										
35-39										
30-34										
<30										
TOTAL		20	45	42	15	8	2			
NUMBER	0	12	27	25	9	5	1	0	0	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84			2							
75-79		3	2							
70-74					2					
65-69			2	2						
60-64				2						
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		3	5	3	2					
NUMBER	0	2	3	2	1	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100	TOTAL	NUMBER
<100												0
95-99												0
90-94											10	6
85-89											143	85
80-84											249	148
75-79			2								250	149
70-74											173	103
65-69											76	45
60-64											44	26
55-59											25	15
50-54											13	8
45-49											3	2
40-44												0
35-39												0
30-34												0
<30											13	8
TOTAL			2								1000	
NUMBER	0	0	1	0	0	0	0	0	0	0		595

(con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101209 MC CALL SO 1964-1983

MONTH AUG

WIND SPEED 0-4 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99		2								
90-94		9	2							
85-89	3	36	15	2						
80-84	2	27	34	27						
75-79		20	39	34	10	3	2			
70-74		5	15	19	15	5				
65-69			3	3	3	17	2			
60-64				2	3	7	10	2	3	2
55-59					2	2		3	5	3
50-54			2			2	3	3	7	3
45-49								2		2
40-44										
35-39										
30-34										
<30										9
TOTAL	5	99	111	87	34	36	17	10	15	19
NUMBER	3	58	65	51	20	21	10	6	9	11

WIND SPEED 5-9 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		10	2							
85-89	3	48	22	2						
80-84	2	36	48	20						
75-79		5	31	14	3					
70-74		7	12	14	7	9	2			
65-69			12	12	10	7		2		
60-64			3	14	9	5		3	2	2
55-59			2	7	3	3	5			2
50-54					2	3	2	3	2	5
45-49									5	
40-44										
35-39										
30-34										
<30										
TOTAL	5	106	131	82	34	27	9	9	9	9
NUMBER	3	62	77	48	20	16	5	5	5	5

WIND SPEED 10-14 MPH — RELATIVE HUMIDITY

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94		3								
85-89		9	2							
80-84		12	7	2	2					
75-79		12	20	3						
70-74		3	17	7						
65-69		2	2	5		3	3		2	
60-64					3	3				
55-59					3					
50-54						2				
45-49							2			
40-44										
35-39										
30-34										
<30										
TOTAL		41	48	17	9	9	5		2	
NUMBER	0	24	28	10	5	5	3	0	1	0

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84		2								
75-79		2	3	2						
70-74			2	2						
65-69										
60-64										
55-59										
50-54										2
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		5	5	3						2
NUMBER	0	3	3	2	0	0	0	0	0	1

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84		2								
75-79		2								
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL		3								
NUMBER	0	2	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99	2	1
90-94	26	15
85-89	143	84
80-84	221	130
75-79	206	121
70-74	140	82
65-69	89	52
60-64	73	43
55-59	41	24
50-54	41	24
45-49	10	6
40-44		0
35-39		0
30-34		0
<30	9	5
TOTAL	1000	
NUMBER		587

(con.)

Table 28 (Con.)

TEMPERATURE - RELATIVE HUMIDITY - WINDSPEED
PERCENTAGE FREQUENCY OF OCCURRENCE FOR SELECTED COMBINATIONS
-GIVEN TO TENTHS PERCENT, DECIMAL POINT OMITTED

STATION NUMBER 101209 MC CALL SO 1964-1983

MONTH SEP

WIND SPEED 0-4 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		6								
80-84	2	12	8	4	4					
75-79		22	34	24	4					
70-74		10	32	14	4	6				
65-69		4	28	24	4	6	2			
60-64		4	16	10	16	16	6	8		
55-59			6	10	2	4	4	4	6	6
50-54			6	6	8		10	4	10	4
45-49				4	4			6	2	10
40-44					2	4			4	6
35-39										
30-34										
<30										
TOTAL	2	58	130	96	48	36	22	22	22	26
NUMBER	1	29	65	48	24	18	11	11	11	13

WIND SPEED 5-9 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84		14	18	2	2					
75-79		12	30	14	6	2				
70-74		10	34	36	8	2				
65-69			22	16	14	2				
60-64		6	10	24	24	4		2		
55-59			4	10	8	8	10	6		
50-54			2	6	6	4				4
45-49				2	4	4	6	4	6	
40-44						2	2	4		2
35-39						2				6
30-34										
<30										
TOTAL		44	120	110	72	30	18	16	6	12
NUMBER	0	22	60	55	36	15	9	8	3	6

WIND SPEED 10-14 MPH

TEMP. DEG F	RELATIVE HUMIDITY 1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89		2								
80-84		2								
75-79		2	6	2						
70-74			18	6	2					
65-69			2	6	2					
60-64			6	4		2				
55-59				4	8	2			2	
50-54		2		4	2	2			2	2
45-49			2				4	2	2	
40-44						2				
35-39										
30-34										
<30										
TOTAL		8	34	26	14	8	4	2	6	2
NUMBER	0	4	17	13	7	4	2	1	3	1

WIND SPEED 15-19 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69				2						
60-64				2						
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL				4						
NUMBER	0	0	0	2	0	0	0	0	0	0

WIND SPEED GREATER/EQUAL 20 MPH

TEMP. DEG F	1 TO 10	11 TO 20	21 TO 30	31 TO 40	41 TO 50	51 TO 60	61 TO 70	71 TO 80	81 TO 90	91 TO 100
<100										
95-99										
90-94										
85-89										
80-84										
75-79										
70-74										
65-69										
60-64										
55-59										
50-54										
45-49										
40-44										
35-39										
30-34										
<30										
TOTAL										
NUMBER	0	0	0	0	0	0	0	0	0	0

TEMP. DEG F	TOTAL	NUMBER
<100		0
95-99		0
90-94		0
85-89	10	5
80-84	68	34
75-79	158	79
70-74	182	91
65-69	134	67
60-64	160	80
55-59	104	52
50-54	84	42
45-49	62	31
40-44	28	14
35-39	8	4
30-34		0
<30		0
TOTAL	1000	
NUMBER		499

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Finklin, Arnold I. 1988. Climate of the Frank Church-River of No Return Wilderness, central Idaho. Gen. Tech. Rep. INT-240. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 221 p.

Describes the climate of the largest designated wilderness in the conterminous United States. Contains numerous maps, graphs, and tables. Shows annual patterns and 10-day details during the fire season. Includes both average values and frequency distributions. Examines relationship of climatic averages to topography, persistence of weather, and climatic trends.

KEYWORDS: climate, mountain climatology, fire-weather, fire management

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Density and Biomass of Trout and Char in Western Streams

William S. Platts
Michael L. McHenry

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THE AUTHORS

WILLIAM S. PLATTS is a research fishery biologist for the Intermountain Research Station in Boise, ID. He received a B.S. degree in conservation education in 1955 from Idaho State University, and an M.S. degree in fisheries in 1957 and a Ph.D. degree in fisheries in 1972 from Utah State University. From 1962 to 1966, he worked as a regional fishery biologist and supervisor in enforcement with the Idaho Fish and Game Department. From 1966 through 1976, he was the Idaho zone fishery biologist for the Intermountain Region, Forest Service, U.S. Department of Agriculture, and consultant to the Surface Environment and Mining (SEAM) program. He has been in his present position since 1976.

MICHAEL L. MCHENRY, is a biological technician with the Intermountain Research Station in Boise, ID. He received a B.S. degree in fisheries from Humboldt State University in 1983 and an M.S. in fisheries from New Mexico State University in 1986. He has been employed with the Station since 1985.

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Intermountain Research Station
324 25th Street
Ogden, UT 84401

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INTRODUCTION

The protection and health of aquatic ecosystems has received increasing attention during the last two decades. Public concern and activism during the 1960's and 1970's led to congressional mandates such as the National Environmental Policy Act (NEPA) of 1969. This act requires agencies of the Federal government to identify the potential environmental effects of any development to be addressed in Environmental Impact Statements (EIS) and Environmental Impact Reports (EIR). Other legislative acts, such as the Federal Land Policy and Management Act of 1976, mandate the Bureau of Land Management, U.S. Department of the Interior, to inventory the resources of the 473 million acres under its jurisdiction and call for comprehensive land use planning. Similarly, the Forest Service, U.S. Department of Agriculture, through the National Forest Management Act (1976), has been directed to develop on each of 156 National Forests an inventory of all resources and their respective condition culminating in long-term management plans that respond to public concerns and management issues. Biological populations, including native and exotic fisheries, are a critical element of these planning processes. In an era of complex multiple-use conflicts, knowledge of resources is of paramount importance. This report presents inventory data on a regional perspective that will assist land-use planning and management requirements concerning fish populations as outlined under Federal law.

A fish population is shaped by the geologic, chemical, physical, and biological factors within and surrounding the environment in which it lives. The relative quality of that environment affects the organisms living there, exerting positive or negative pressure on the population. A relatively simple and inexpensive method of evaluating the health of lentic systems is to monitor the density and biomass of the fish population. Because lower trophic levels are difficult, costly, and often time consuming to monitor, surveys of fish populations may be used to provide an overall measure of ecosystem health. The size, structure, and growth rates of fish populations allow determination of habitat condition, as well as inferences about lower trophic levels.

Fishery biologists are routinely requested to evaluate the physical and biotic potential of aquatic habitats, or the effects of various land uses such as logging, grazing, mining, and hydroelectric power development on these habitats. Stream surveys are often designed to evaluate the quality of lentic habitats, which in the Western United States are dominated geographically by economically important trout and char of the genera *Salmo* and *Salvelinus*. Evaluation of a particular fisheries resource typically involves the measures of the species population characteristics.

Important measures of a stream's health and productivity are the density, biomass, and species composition of fishes in a given stream. Once these measures are obtained, a biologist must know how a particular stream compares to other streams of similar condition. A comparison of the biomass/density of similar species from different geographical regions is often difficult because the literature is usually incomplete. Most data concerning trout density and biomass are scattered, found mainly in obscure State publications ("gray literature") that rarely are distributed or indexed. As a result, biologists often make comparisons between their particular population and trout/char populations in New Zealand, Denmark, or Scotland, where such data have been commonly published and indexed. Unfortunately, such comparisons are not only misleading but perhaps meaningless. This paper represents the first compilation of trout population characteristics in the Western United States.

The primary purpose of this publication is to help bridge this data gap by presenting density and biomass information from a variety of stream habitats representative of lentic ecosystems in the 11 Western States. Aquatic resource managers can use these data as an aid when considering fish population needs during planning and management.

The following fish species are discussed in this publication:

Common name	Scientific name
Apache (Arizona) trout	*Salmo apache*
Atlantic salmon	*Salmo salar*
Brook trout	*Salvelinus fontinalis*
Brown trout	*Salmo trutta*
Bull trout	*Salvelinus confluentus*
Cutthroat trout	*Salmo clarki* spp.
Gila trout	*Salmo gilae*
Golden trout	*Salmo aquabonita*
Rainbow trout	*Salmo gairdneri*

METHODS

Density and biomass of salmonids in western streams were obtained from a variety of stream habitats, either directly through the research of the authors, by personal communication with fishery specialists, or from the literature. Although some large streams were included in the analysis, the emphasis was upon smaller streams (less than 8 m width), where evaluation techniques are usually more effective and accurate. We made an effort to obtain a comprehensive data base, but some geographic gaps are

evident. We were unable to locate extensive fish population data in northern Arizona, eastern Washington, northern New Mexico, and southern Nevada, where, we conclude, extensive surveys of trout populations are nonexistent or poorly documented.

Trout density and biomass are listed in numbers per square meter (fish/m^2) and grams per square meter (g/m^2), respectively, except where stream surface area was unavailable. In those instances, values were listed as numbers or grams per linear meter (fish/m, g/m). When data from several stream stations or time-series data were available, a range of high and low values and arithmetic means are provided. If only one station was sampled, the value is listed singly under the range column and a dash was entered in the arithmetic mean column.

Many of the data points were obtained from studies concerning the effects of various land uses (such as logging, mining, grazing) upon trout populations. In these instances only data from control sections were used. Thus, the density and biomass levels presented here mainly reflect levels that might be found in pristine or lightly altered stream systems. We also avoided streams that were heavily stocked with livestock.

The vast majority of trout population data was obtained by electrofishing techniques. However, the accuracy of reported estimates was difficult to determine because measures of statistical precision were rarely reported.

Figure 1—Geographic ecoregions of the Western United States, adapted from Bailey (1980): Pacific Forest, Sierra Nevada Forest, Columbia Forest, Intermountain Sagebrush, Rocky Mountain Forest, Colorado Plateau, and Upper Gila Mountains.

Geographic Region

Because State boundaries do not delineate various land surface forms, and because we wanted to provide for geographic consistency, we grouped streams by ecoregion following the classification of Bailey (1980). Some minor changes were made in Bailey's provinces to better reflect drainage patterns. A province or ecoregion was defined as a geographic area delineated by differences in geologic landform and climates as expressed by broad vegetation patterns. Analysis by ecoregion allows interregional comparisons with the assumption that the streams of concern are roughly similar in regards to geologic processes, climatic conditions, dominant vegetation, and landform. Thus, it may be possible to make meaningful comparisons. Trout/char density and biomass are given for seven ecoregions of the Western United States (fig. 1): Pacific Forest, Sierra Nevada Forest, Columbia River Forest, Intermountain Sagebrush, Rocky Mountain Forest, Colorado Plateau, and Upper Gila Mountain.

Statistical Analysis

Density and biomass of salmonids were grouped regionally and plotted by frequency of occurrence. Because of the skewed distribution of the data and apparent heterogeneity of the variance, medians of each region were calculated as well as other descriptive statistics. Box plots (Chambers and others 1983) were generated by region for both trout density and biomass. Box plots represent graphic summarizations of data but require some explanation. In the box plot, the upper 75th and lower 25th percentiles are represented by the top and bottom of the rectangle, respectively. Thus, the box illustrates the spread of the bulk of the data (the central 50 percent). The box plot allows a partial assessment of symmetry. If the distribution of the data is symmetrical, the median will divide the box into equal halves. The solid lines represent tails of the data distribution, while isolated circles are outlying data points.

To test for biomass differences between and among regions and individual species, we used one-way analysis of variance (ANOVA) and the Fisher's Least Significant Difference (LSD) test (Ott 1984) at the 0.05 percent significance level. Data analysis was analyzed on an IBM PC using the General Linear Model procedure of SAS (SAS Institute 1985).

We explored the relationship between trout biomass and density through least squares regression techniques (Sokal and Rohlf 1973) using biomass as the dependent variable. Data analysis was executed using the regression procedure of SAS (SAS Institute 1985).

Regional biomass curves were developed and plotted through least squares regression techniques and curve fitting routines using a Hewlett-Packard 9845 computer. It should be noted that neither the coefficient of determination nor the significance for these curves was reported. These curves represent planning aids and do not depict cause and effect relationships. Therefore, to prevent their misuse, formulas have been omitted.

RESULTS

We analyzed data from 313 streams in the Western United States for trends and significant differences. Biomass of salmonids in western streams exhibited tremendous variability, ranging from 0 to 81.9 g/m^2 (tables 1-7) and averaging 5.4 g/m^2 for all sites. Regionally, streams in the Gila Mountain region occupied by the endangered Gila and Arizona trouts had the highest mean biomass, averaging 9.1 g/m^2. Sierra Nevada Forest streams had the greatest range and the second highest average biomass (8.2 g/m^2), followed closely by streams of the Rocky Mountain Forest region (7.7 g/m^2) and Colorado Plateau (6.1 g/m^2). Trout streams of the Intermountain Sagebrush and Columbia River Forest ecoregions averaged 4.0 and 3.8 g/m^2, respectively. Streams within the Pacific Forest ecoregion exhibited the smallest range of values as well as the lowest mean biomass (table 8). Significant differences between regions were found at the 0.01 percent level (ANOVA F = 4.80). Results of the Fisher's LSD test depict the significant differences between individual ecoregions and are depicted in table 9. The Fisher's LSD test is a multiple comparison of the difference between paired means through Student's *t*-tests. For example, the first line in table 9 compares the biomass of trout in the Rocky Mountain region with trout in the Gila Mountain region. The table indicates that trout biomass of the Rocky Mountain region is 2.38 g/m^2 less than that of the Gila Mountain region. However, the difference was not significant at the 0.05 percent level. Confidence intervals (95 percent were then generated around the mean difference of the regions being tested.

Table 1—Density and standing crop biomass of salmonids in selected streams within the Pacific Forest ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Badger Creek, OR	Brook/Rainbow	(0.14 to 0.32)	0.22	(2.7 to 5.4)	4.5	USDA FS 1985
Barlow Creek, OR	Brook/Rainbow	(0.13 to 0.19)	.16	(1.3 to 3.0)	2.2	USDA FS 1985
Bear Creek, WA	Cutthroat	(0.13 to 0.42)	.30	(1.5 to 3.6)	2.4	June 1981
Boulder Creek, OR	Brook/Rainbow	(0.12 to 0.17)	.14	(2.5 to 2.8)	2.7	USDA FS 1985
Bonney Creek, OR	Brook/Rainbow	0.04	—	0.24	—	USDA FS 1985
Buck Creek, OR	Brook/Rainbow	0.08	—	0.91	—	USDA FS 1985
Bull Creek, WA	Cutthroat	(0.052 to 0.074)	.063	(1.1 to 1.4)	1.3	Martin and others 1981
Cane Creek, OR	Cutthroat	0.55	—	1.14	—	Murphy 1979
Caspar Creek, (N. Fk.), CA	Rainbow	—	—	(0.9 to 1.4)	1.2	Burns 1971
Christmas Creek, WA	Cutthroat	(0.15 to 0.39)	.26	(2.0 to 3.7)	2.7	USDA FS 1985
Clear Creek, OR	Brook/Rainbow	(0.10 to 0.16)	.12	(1.7 to 3.2)	2.4	USDA FS 1985
Cook Creek, OR	Cutthroat	0.97	—	0.75	—	Murphy 1979
Deer Creek, OR	Cutthroat	(0.32 to 0.39)	.34	—	4.6	Hall and Lantz 1969
Flynn Creek, OR	Cutthroat	(0.38 to 0.49)	.43	—	4.8	Hall and Lantz 1969
Forest Creek, OR	Brook/Rainbow	0.44	—	9.3	—	Hall and Lantz 1969
Gate Creek, OR	Brook/Rainbow	(0 to 0.19)	.09	(0 to 5.8)	1.8	Hall and Lantz 1969
Gate Creek, (S. Fk.), WA	Brook/Rainbow	0.07	—	1.5	—	Martin and others 1981
Godwood Creek, (N. Fk.), CA	Cutthroat/Rainbow	(0.09 to 0.18)	.10	(0.49 to 0.57)	0.53	Burns 1971
Greenback Creek, WA	Cutthroat	0.25	—	1.7	—	WDF 1984
Hadsell Creek, OR	Cutthroat	—	—	(4.8 to 5.5)	5.1	USDA FS 1985
Honor Camp Creek, WA	Cutthroat	(0.23 to 1.3)	.74	(1.8 to 4.8)	3.3	Osborn 1981
Hurst Creek, WA	Cutthroat	(0 to 0.02)	.009	(0 to 0.54)	0.24	Osborn 1981
Iron Creek, OR	Brook/Rainbow	0.13	—	3.9	—	USDA FS 1985
Jordan Creek, OR	Brook/Rainbow	(0.18 to 0.54)	.41	(5.7 to 10.7)	7.3	USDA FS 1985
Little Badger Creek, OR	Brook/Rainbow	(0 to 0.51)	.26	(0 to 3.7)	2.2	USDA FS 1985
Lewis River, (E. Fk.), WA	Cutthroat	0.3	—	(0.04 to 0.77)	0.4	WDF 1984
Lookout Creek, OR	Cutthroat	(0.11 to 0.40)	.25	(0.24 to 0.30)	0.27	Murphy 1979
Mack Creek, OR	Cutthroat	1.06	—	0.28	—	Murphy 1979
McKinely Creek, WA	Cutthroat	—	—	2.9	—	WDF 1984
McRae Creek, OR	Cutthroat	(0 to 0.54)	0.12	(0 to 0.56)	0.17	Murphy 1979
Mill Creek, OR	Cutthroat	1.1	—	1.4	—	Hall and Lantz 1969
Miller Creek, WA	Cutthroat	(0.004 to 0.07)	.04	(0.069 to 1.44)	2.3	WDF 1984
Miller Creek, (E. Fk.), WA	Cutthroat	(0 to 0.16)	.07	(0 to 2.9)	1.5	WDF 1984
Mineral Creek, OR	Brook/Rainbow	0.14	—	2.4	—	USDA FS 1985
Mona Creek, OR	Cutthroat	0.33	—	0.77	—	Murphy 1979
Needle Creek, OR	Cutthroat	(0.22 to 0.40)	.29	3.3	—	Hall and Lantz 1969
Octopus Creek, WA	Cutthroat	(0.47 to 1.8)	1.1	(3.9 to 7.7)	5.9	Osborn 1981
Rebel Creek, OR	Cutthroat	0.46	—	0.62	—	Murphy 1979
Rock Creek, WA	Cutthroat	—	—	0.09	—	WDF 1984
Shale Creek, WA	Cutthroat	(0.032 to 0.052)	.043	(0.78 to 1.1)	0.96	WDF 1984
Simmonds Creek, OR	Cutthroat	0.07	—	0.87	—	Murphy 1979
Slide Creek, WA	Cutthroat	—	—	0.02	—	Martin and others 1981
Snahapish River, (W. Fk.), WA	Cutthroat	(0.056 to 0.15)	.10	(1.6 to 3.7)	2.6	Osborn 1981
Solleks River, WA	Cutthroat	(0.026 to 0.056)	.046	(0.91 to 1.3)	1.0	WDF 1984
Stequaleho Creek, WA	Cutthroat	(0.013 to 0.047)	.036	(0.266 to 1.3)	1.0	Martin and others 1981
Stequaleho Creek, (E. Fk.), WA	Cutthroat	(0.15 to 0.56)	.31	(1.4 to 3.2)	2.1	Martin and others 1981
Stequaleho Creek, (W. Fk.), WA	Cutthroat	(0.13 to 0.54)	.31	(0.74 to 2.8)	1.9	Martin and others 1981
Sugar Creek, OR	Cutthroat	0.36	—	0.65	—	USDA FS 1985
Ten Williamette River Basin Tribs	Cutthroat	(0.25 to 2.51)	—	—	—	Nickelson and Hafele 1978
Thermos Creek, OR	Cutthroat	0.20	—	0.14	—	Murphy 1979
Threemile Creek, OR	Cutthroat	(0 to 0.8)	.46	(0 to 11.9)	6.3	USDA FS 1985
Tygh Creek, OR	Brook/Rainbow	(0 to 0.36)	.25	(0 to 5.3)	3.2	USDA FS 1985
Walker Creek, OR	Cutthroat	0.02	—	0.07	—	Murphy 1979
White River, OR	Brook/Rainbow	(0.03 to 0.06)	.04	(1.1 to 3.7)	1.9	USDA FS 1985
Wycoff Creek, OR	Cutthroat	0.33	—		—	Murphy 1979
Yaker Creek, (S. Fk.), CA	Rainbow	(0.71 to 1.05)	.9	(2.9 to 4.2)	3.5	Burns 1971

Table 2—Density and standing crop biomass of salmonids in selected streams within the Sierra Forest ecoregion

Stream	Species	Density (range)	X	Biomass (range)	X	Source[1]
		Fish/m²		*g/m²*		
Alder Creek, CA	Brown/Rainbow	(0.13 to 0.26)	0.19	(2.5 to 7.0)	4.7	
Bear Creek, CA	Brown/Rainbow	—	—	8.9	—	
Birch Creek, CA	Brook/Brown/Rainbow	(0.19 to 0.35)	.27	(10.3 to 15.3)	12.8	
Birch Creek, CA	Brook	0.03	—	3.8	—	
Bishop Creek, CA	Brown	(0.20 to 0.45)	.3	(8.6 to 15.2)	11.8	
N.Fk. Bishop Creek, CA	Brook/Brown/Rainbow	0.48	—	26.9	—	
S.Fk. Bishop Creek, CA	Brown/Rainbow	(0.21 to 0.62)	.36	(14.8 to 24.3)	18.2	
E.Fk. Carson River, CA	Rainbow/Brown/Cutthroat	(0.003 to 0.09)	.03	(0.3 to 2.3)	1.4	
W.Fk. Carson River, CA	Brook/Brown/Rainbow	(0.004 to 0.02)	.01	(0.4 to 1.9)	1.1	
Cold Stream, CA	Brook/Brown	0.07	—	2.8	—	
Coldwater Creek, CA	Rainbow	0.01	—	4.5	—	
Convict Creek, CA	Brown/Rainbow	(0.13 to 0.55)	.30	(7.2 to 17.7)	11.7	Needham and others 1945
Cosumnes River, CA (N. Fk.)	Rainbow/Brown	—	—	(3.0 to 11.6)	6.9	
Cottonwood Creek, CA	Golden	(0.15 to 0.25)	.20	(4.4 to 9.8)	7.6	
Deadman Creek, CA	Brook/Brown/Rainbow	(0.08 to 0.14)	.11	(2.3 to 2.4)	2.3	
Deer Creek, CA	Rainbow/Brown	(0.02 to 0.10)	.05	(2.9 to 13.4)	7.5	
Deer Creek, CA	Brook/Brown/Rainbow	0.18	—	4.7	—	
Dinkey Creek, CA	Brown/Rainbow	—	—	(5.4 to 5.9)	5.7	
Estroy Creek, CA	Rainbow/Brown	0.10	—	13.4	—	
Fall River, CA	Rainbow	0.004	—	14.0	—	
Forest Creek, CA	Rainbow/Brown	(0.03 to 0.07)	.05	(3.1 to 5.9)	4.6	
Glass Creek, CA	Brook	(0.4 to 0.5)	.45	(16.4 to 22.5)	19.4	
Greenhorn Creek, CA	Brown/Rainbow	0.02	—	3.1	—	
Horseshoe Meadow Creek, CA	Golden	0.61/m	—	8.4 g/m	—	
Horton Creek, CA	Brook/Brown/Rainbow	(0.13 to 0.29)	.19	(7.5 to 12.9)	9.9	
Hot Creek, CA	Brown/Rainbow	0.48	—	81.9	—	
Independence Creek, CA	Brook/Brown/Rainbow	(0.09 to 0.52)	.3	(7.8 to 15.5)	11.6	
Independence Creek, CA	Brown/Rainbow	0.07	—	2.2	—	
Juniper Creek, CA	Brook/Rainbow	0.09	—	2.9	—	
Kern River, CA	Brown/Rainbow	—	—	(0.6 to 6.0)	3.3	
Kern River, CA (South Fork)	Brown/Golden	—	—	(13.3 to 13.4)	13.3	
Kirkwood Creek, CA	Brook/Brown	(0.05 to 0.16)	.10	(4.8 to 10.2)	7.5	
Last Chance Creek, CA	Brown/Rainbow	(0.01 to 0.03)	.02	(1.3 to 9.5)	4.1	
Little Truckee R., CA	Brown/Rainbow	(0.007 to 0.19)	.05	(0.7 to 1.4)	1.3	
Lone Pine Creek, CA	Brown/Rainbow	(0.29 to 0.91)	.6	(3.9 to 4.9)	4.4	
Mammoth Creek, CA	Brown/Rainbow	(0.05 to 0.23)	.26	(8.8 to 38.4)	18.0	
Marble Fork, CA	Brown/Rainbow	—	—	(3.5 to 12.7)	6.5	
Martis Creek, CA	Brown/Cutthroat/Rainbow	(0.19 to 0.57)	.32	(8.3 to 11.6)	9.6	Moyle and Vondracek 1985
McGee Creek, CA	Brook/Brown	(0.47 to 0.67)	.57	(19.2 to 21.6)	20.4	
Merced River, CA	Brown/Rainbow	—	—	(0.8 to 4.5)	2.2	
South Fork Mokelumne River, CA	Rainbow/Brown	0.06	—	9.1	—	
North Fork Mokelumne River, CA	Rainbow/Brown	(0.01 to 0.06)	.02	(0.7 to 8.5)	3.4	
Mono Creek, CA	Brown	—	—	(4.0 to 8.9)	6.5	
North Fork Oak Creek, CA	Brown	0.06	—	2.0 g/m	—	
Olancha Creek, CA	Brown/Rainbow	0.1	5.4	—		
Oregon Creek, CA	Rainbow	(0.008 to 0.01)	.01	(0.9 to 2.6)	1.7	
Owens River, CA	Brown	(0.05 to 0.89)	.27	(1.5 to 82.9)	28.7	
Perazzo Creek, CA	Brook/Brown/Rainbow	0.08	—	5.8	—	
Pilot Creek, CA	Brown/Rainbow	0.008	—	1.8	—	
Pine Creek, CA	Brown/Rainbow	0.08	—	7.6	—	
Pleasant Valley Creek, CA	Rainbow/Brown	(0.01 to 0.02)	.015	(2.4 to 3.5)	2.9	
Pole Creek, CA	Cutthroat	0.04	—	2.6	—	
Poorman Creek, CA	Brown/Rainbow	0.04	—	10.8	—	
South Fork Prosser Creek, CA	Brown/Rainbow	0.01	—	1.1	—	
Red Clover Creek, CA	Brown/Rainbow	(0.02 to 0.02)	.02	(0.9 to 2.7)	1.8	
Red Lake Creek, CA	Brook/Rainbow	0.34	—	9.8	—	
Red Mountain Creek, CA	Brown	(0.34 to 0.56)	.45	(21.1 to 30.8)	25.9	
Rock Creek, CA	Brown	(0.007 to 0.29)	.07	(0.5 to 9.7)	1.8	
Rubicon Creek, CA	Brook/Brown/Rainbow	(0.005 to 0.08)	.04	(1.2 to 5.6)	3.4	
Sagehen Creek, CA	Brown/Rainbow	(0.03 to 0.11)	.07	(2.6 to 5.9)	4.2	
San Joaquin River, (S. Fk.), CA	Brown/Rainbow	—	—	(4.6 to 5.6)	5.1	
Shepherd Creek, CA	Brook/Brown/Rainbow	(0.02 to 0.21)	.09	(1.1 to 8.3)	4.3	
Silver Creek, CA	Brook/Brown/Rainbow	0.26	—	6.5	—	

(con.)

Table 2 (Con.)

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source[1]
		Fish/m²		*g/m²*		
Silver Creek, CA (S. Fk.)	Brown/Rainbow	(0.01 to 0.01)	.01	(1.1 to 1.2)	1.2	
Spratt Creek, CA	Rainbow	0.27	—	2.1	—	
Middle Fork Stanislaus River, CA	Brown/Rainbow	—	—	(0 to 13.4)	6.7	
Sutter Creek, CA	Rainbow/Brown	(0.02 to 0.03)	.02	(2.0 to 2.6)	2.3	
Taboose Creek, CA	Brown/Rainbow	(0.04 to 0.52)	.28	(2.0 to 11.5)	6.7	
Tinemaha Creek, CA	Brown/Rainbow	(0.08 to 0.39)	.23	(6.9 to 9.6)	7.9	
Trout Creek, CA	Rainbow	—	—	3.1	—	
Truckee River, CA	Brown/Rainbow	(0.008 to 0.04)	.02	(1.1 to 5.9)	2.8	
Tuttle Creek, CA	Brown/Rainbow	(0.49 to 0.50)	.49	(9.5 to 15.4)	12.4	
Weaver Creek, CA	Brown/Rainbow	0.05	—	5.7		
Wet Meadows Creek, CA	Golden	—	—	7.0		
Wolf Creek, CA	Brown/Rainbow/Brook	—	.03	(0.6 to 1.4)	1.0	

[1]Data provided by the California Department of Fish and Game, Wild Trout Project.

Table 3—Density and standing crop biomass of salmonids in selected streams within the Columbia Forest Province

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Bakeoven Creek, OR	Brook/Brown/Rainbow	0.71/m		23.3	—	USDA FS 1985
Beaver Creek, ID	Cutthroat	(0.05 to 0.1)	0.07	(1.0 to 2.3)	1.6	Rabe and others 1975
Big Creek, ID	Cutthroat/Brook	(0.02 to 0.21)	.15	—		Rabe and others 1975
Big Bear Creek, ID	Rainbow	(0 to 0.31)	.1	(0 to 4.5)	1.5	Johnson 1985
Big Boulder Creek, ID	Cutthroat/Rainbow	0.02		1.0	—	Rabe and others 1975
Big Lake Creek, ID	Cutthroat/Rainbow	0.04	—	2.3	—	Rabe and others 1975
Bond Creek, ID	Cutthroat/Brook	(0.09 to 0.27)	.15	—	—	Rabe and others 1975
Bruno Creek, ID	Cutthroat	0.01	—	2.7	—	Rabe and others 1975
Canal Gulch, ID	Brook	0.33	—	0.8	—	Johnson 1985
Cedar Creek, ID	Rainbow	0.36	—	1.5	—	Johnson 1985
Cellars Creek, ID	Cutthroat/Brown	(0.24 to 0.29)	.27	(11.1 to 13.8)	12.6	Rabe and others 1975
Clear Creek, ID	Cutthroat	(0 to 0.8)	.2	(0 to 6.5)	1.7	Johnson 1985
Clear Creek, ID (W. Fk.)	Cutthroat	0.33	—	5.2	—	Johnson 1985
Cow Creek, ID	Brook	0.01	—	0.2	—	Johnson 1985
Elk Creek, OR	Brook/Brown/Rainbow	0.04/m	—	2.9	—	
Garden Creek, ID	Cutthroat	(0.01 to 0.03)	.02	(1.1 to 1.9)	1.5	Rabe and others 1975
Horton Creek, ID	Brook	(0.03 to 0.12)	.085	(0.05 to 0.1)	.07	Authors
John Day River, OR (M. Fk.)	Mixed	0.1/m	—	5.3	—	
Johnson Creek, ID	Brook	(0.15 to 0.45)	.21	(2.2 to 5.6)	3.6	Authors
Kinnikinic Creek, ID	Cutthroat	(0.11 to 0.13)	.12	(5.4 to 7.8)	6.6	Rabe and others 1975
Lake Creek, ID	Rainbow	(0.13 to 0.20)	.11	(4.9 to 5.2)	5.1	Rabe and others 1975
Little Beaver Creek, ID	Brook	0.06	—	1.1	—	Johnson 1985
Little Boulder Creek, ID	Rainbow	2.5	—	6.4	—	Johnson 1985
Little Deschutes River, OR	Brown	—	—	(4.8 to 21.8)	9.4	
Lyon Creek, ID	Rainbow	0.04	—	1.0	—	Rabe and others 1975
Marble Creek, ID	Cutthroat	(0.01 to 0.17)	.07	—	—	Rabe and others 1975
Mica Creek, ID	Brook/Bull/Cutthroat	(0.03 to 0.23)	.09	—	—	Mauser 1972
Mill Creek, ID	Cutthroat	0.03	—	1.3	—	Rabe and others 1975
Orofino Creek, ID	Brook	(0 to 0.01)	.001	(0 to 0.42)	.06	Johnson 1985
Peavine Creek, OR	Brook/Brown/Cutthroat	0.1/m	—	14.6	—	USDA FS 1985
Pine Creek, OR	Brook/Brown/Cutthroat	0.006/m	—	2.8	—	USDA FS 1985
Pine Knob Creek, ID	Cutthroat	0.53	—	7.1	—	Johnson 1985
Poorman Creek, ID	Brook	0.15	—	1.0	—	Johnson 1985
Potlatch Creek, ID (N. Fk.)	Brook/Rainbow	(0.001 to 0.05)	.02	(0.06 to 1.5)	.6	Johnson 1985
Quartz Creek, ID	Cutthroat	(0.13 to 0.19)	.16	—	—	Johnson 1985
Red River, ID (N. Fk.)	Brook/Bull/Cutthroat/Rainbow	(0.03 to 0.05)	.04	(0.68 to 0.95)	.81	Authors
Red River, ID (S. Fk.)	Brook/Bull/Cutthroat/Rainbow	(0.02 to 0.03)	.02	(0.62 to 0.88)	.75	Authors
Reeds Creek, ID	Brook/Cutthroat	(0.28 to 0.40)	.33	—	—	
Road Creek, ID	Cutthroat	(0.02 to 0.06)	.03	(0.86 to 1.8)	1.4	Rabe and others 1975
Rochat Creek, ID	Brook/Cutthroat	(0.2 to 1.6/m)	1.0/m	—	4.7	Rabe and others 1975
Salmon River, ID (S. Fk.)	Bull	(0.09 to 0.66)	.26	(1.1 to 3.9)	2.5	Authors
Shanghai Creek, ID	Brook	0.91	—	7.9	—	Johnson 1985
Silvies River, OR	Brook/Brown/Rainbow	0.04/m	—	5.5	—	USDA FS 1985
Simmons Creek, ID	Bull/Cutthroat/Rainbow	(0.03 to 0.15)	.07	—	—	Rabe and others 1975
Squaw Creek, ID	Bull/Cutthroat/Rainbow	(0.01 to 0.02)	.01	(1.2 to 1.3)	1.2	Rabe and others 1975
Thompson Creek, ID	Bull/Cutthroat/Rainbow	(0.01 to 0.08)	.03	(0.3 to 5.2)	1.9	Rabe and others 1975
Trail Creek, ID	Brook	(0.05)	—	1.8	—	Johnson 1985
Trapper Creek, ID	Bull/Cutthroat	(0.15 to 0.22)	.18	(2.1 to 2.3)	2.2	Authors
Trout Creek, ID	Brook/Cutthroat	(0.03 to 0.72)	.27	—	—	Rabe and others 1975
Trout Creek, OR	Brook/Brown/Rainbow	0.5/m	—	4.0	—	USDA FS 1985

Table 4—Density and standing crop biomass of salmonids in selected streams within the Intermountain Sagebrush ecoregion (Great Basin)

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Big Creek, UT	Brown/Cutthroat/Rainbow	(0.01 to 0.03)	0.018	(0.2 to 1.3)	0.8	Authors
Birch Creek, UT	Brook/Cutthroat	0.17	—	6.5	—	UDNR 1980
Boyd Creek, NV	Rainbow	0.49	—	1.0	—	NDOW 1980
Brown Creek, NV	Brook	0.11	—	2.9	—	NDOW 1980
Camp Creek, NV	Rainbow	(0.01 to 0.18)	.09	—	—	NDOW 1980
Care Creek, NV	Brook	0.11	—	0.1	—	NDOW 1980
Chimney Creek, NV	Humboldt Cutthroat	(0.06 to 0.6)	.34	(1.9 to 3.2)	2.2	Authors
Conners Creek, NV	Lahontan Cutthroat	(0.11 to 0.26)	.18	—	—	NDOW 1980
Cottonwood Creek, NV	Rainbow	(0.01 to 0.25)	.08	12.2	—	Authors
Cutt Creek, NV	Lahontan Cutthroat	(0.07 to 10.8)	3.6	—	—	NDOW 1980
Deep Creek, NV	Rainbow	0.19	—	2.2	—	NDOW 1980
Deer Creek, NV	Brook	(0.008 to 0.21)	.09	—	—	NDOW 1980
Draw Creek, NV	Lahontan Cutthroat	(0.25 to 1.7)	.76	—	—	NDOW 1980
Dunn Creek, UT	Rainbow	0.12	—	4.1	—	UDNR 1980
Fisher Creek, UT	Rainbow	0.39	—	8.0	—	UDNR 1980
Gance Creek, NV	Humboldt Cutthroat	(0.02 to 0.10)	.06	(4.2 to 13.6)	8.9	Authors
Jack Creek, NV	Brook/Rainbow	0.38	—	5.4	—	NDOW 1980
Kelley Creek, NV	Brook/Rainbow	0.35	—	4.8	—	NDOW 1980
Kendall Creek, ID	Brook/Cutthroat	1.02	-	—	—	Neve and Moore 1983
Marys River, NV	Lahontan Cutthroat	(0.001 to 0.02)	07	—	—	NDOW 1980
Mitchell Creek, NV	Cutthroat	0.21	·	12.7	—	NDOW 1980
Murphy Creek, NV	Brook	0.09	—	1.2	—	NDOW 1980
North Fork Humboldt River, NV	Brook/Cutthroat	0.06	—	2.2	—	NDOW 1980
North Fork Pratt Creek, NV	Brook	0.03	—	0.5	—	NDOW 1980
Pratt Creek, NV	Brook	0.02	—	0.7	—	NDOW 1980
Rattlesnake Creek, NV	Brook/Cutthroat	0.12	—	3.3	—	NDOW 1980
Sage Creek, ID	Brown	0.7	—	—	—	Heimer 1979
Sage Creek, ID (M. Fk.)	Brown	(0 to 0.15)	.075	—	—	Heimer 1979
Sage Creek, ID (N. Fk.)	Brook/Cutthroat	(0.11 to 0.46)	.21	—	—	Heimer 1979
Sage Creek, ID (S. Fk.)	Brown/Cutthroat/Rainbow	(0.32 to 0.36)	.34	—	—	Heimer 1979
Salmon Falls Creek, NV	Rainbow	(0.002 to 0.04)	.02	—	—	NDOW 1980
Smokey Creek, ID	Brook/Cutthroat	0.57	—	—	—	Heimer 1979
Spring Creek, ID	Brook/Cutthroat	(0.66 to 4.78)	2.3	—	—	Neve and Moore 1983
Sun Creek, NV	Rainbow	(0 to 0.62)	.18	—	—	NDOW 1980
Tabor Creek, NV	Rainbow	(0.5 to 0.63)	.23	—	—	Authors
Thomas Creek, NV	Brook	0.02	—	0.3	—	NDOW 1980
Toe Jam Creek, NV	Cutthroat	0.19	—	7.6	—	NDOW 1980
Waterpipe Canyon, NV	Rainbow	0.21	—	1.1	—	NDOW 1980
Wildcat Creek, NV	Lahontan Cutthroat	0.95	—	—	—	NDOW 1980

Table 5—Density and standing crop biomass of salmonids in selected streams within the Rocky Mountain Forest ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Archuleta Creek, CO	Brook/Brown	—		(12 to 20)	16.0	CDOW 1981
Beaver Creek, WY	Brook	—	—	3.4	—	Binns and Eiserman 1979
Bitter Creek, UT	Brook	0.16	—	10.5	—	UDNR 1980
Carnero Creek, CO	Cutthroat	—	—	(5.9 to 6.5)	6.7	CDOW 1981
Coal Creek, CO	Brook	(0.98 to 1.3)	1.1	(1.0 to 2.9)	1.9	Binns and Eiserman 1979
Coantag Creek, WY	Brown/Cutthroat	0.3	—	7.9	—	Remmick 1983
Cochetopa Creek, CO	Brown	(0.019 to 0.065)	—	(0.3 to 1.0)	—	CDOW 1981
Conejos River, CO	Brown	—	—	(4.0 to 10.0)	—	Nehring 1979
Como Creek, CO	Greenback Cutthroat	0.4	—	(0.15 to 6.6)	4.1	Anonymous
Cucharas Creek, CO	Mixed	—	—	19.1	—	CDOW 1981
Cunningham Creek, CO	Brook	—	—	4.4	—	CDOW 1981
Deadman Creek, WY	Bear River Cutthroat	0.04	—	0.89	—	Remmick 1983
Deadcow Creek, WY	Cutthroat	—	—	2.0	—	Binns and Eiserman 1979
Deer Creek, WY	Brown/Rainbow	—	—	5.3	—	Wesche 1980
Douglas Creek, WY	Brown	(2.3 to 9.4)	4.2	(2.6 to 9.1)	5.4	Wesche 1980
East River, CO	Mixed	—	—	11.3	—	Nehring 1983
Encampment River, WY	Brown	(0.6 to 1.6)	1.0/m	(2.3 to 8.5)	5.5	Wesche 1980
Frying Pan Creek, CO	Rainbow	(0.02 to 0.07)	—	(0.2 to 1.0)	—	CDOW 1981
Giraffe Creek, WY	Bonneville Cutthroat	(0.1 to 0.2/m)	.16/m	(2.2 to 4.4)	3.5	Binns and Eiserman 1979
Green River, WY	Brown/Rainbow	—	—	(1.9 to 6.6)	—	Wesche 1980
Gunnison River, Lake Fork, CO	Mixed	—	—	9.1	—	CDOW 1981
Green Timber Creek, WY	Cutthroat	—	—	2.2	—	Binns and Eiserman 1979
Hams Fork River, WY	Brown/Rainbow	—	—	4.4	—	Binns and Eiserman 1979
Harrison Creek, WY	Cutthroat	—	—	2.8	—	Binns and Eiserman 1979
Hog Park Creek, WY	Brown	(0.32 to 0.63/m)	.53/m	—	—	Wesche 1980
Huerfano River, CO	Mixed	—	—	6.2	—	CDOW 1981
Laramie River, WY	Brown	(0.24 to 0.61/m)	.45/m	(5.1 to 14.0)	10.5	Wesche 1980
Lead Creek, WY	Brook/Cutthroat	0.2/m	—	—	—	Remmick 1983
Little Green Creek, CO	Colorado River Cutthroat	(0.10 to 0.35)	.17/m	(3.86 to 3.96)	3.91	Scarnecchia and Bergeson 1986
Little Laramie River, WY	Brown	(0.4 to 1.0/m)	.71/m	(5.9 to 21.2)	13.5	Wesche 1980
Little PopoAgie River, WY	Brown/Rainbow	—	—	4.25	—	Binns and Eiserman 1979
Little Prickly Pear Creek, MT	Mixed	(0.03 to 0.26/m)	.14/m	(4.5 to 25.3)	15.4	Holton 1953
Little South Fork Cache la Poudre River, CO	Mixed	—	—	5.36	—	Nehring 1983
Los Pinos Creek, CO	Brook	(0.13 to 0.31)	—	—	—	CDOW 1981
Maki Creek, WY	Colorado River Cutthroat	0.04/m	—	1.2	—	Remmick 1983
Middle Fork Flathead Tribs., MT	Westslope Cutthroat/ Bull Trout	0.27/m	—	—	—	Leathe 1980
Nash Fork Creek, WY	Cutthroat	—	—	7.8	—	Binns and Eiserman 1979
North Fork Flathead Tribs., MT	Westslope Cutthroat/ Bull Trout	0.24/m	—	—	—	Leathe 1980
North Horse Creek, WY	Cutthroat	0.03/m	—	0.56	—	Remmick 1983
North Platte River, WY	Brown/Rainbow	—	—	5.8	—	Wesche 1980
Nylander Creek, WY	Brook/Colorado River Cutthroat	(0.02 to 0.4/m)	—	15.3	—	Remmick 1983
Paint Creek, WY	Brown/Rainbow	—	—	1.0	—	Remmick 1983
Poker Hollow Creek, WY	Brown/Rainbow/ Brook/Cutthroat	0.1	—	0.5	—	Remmick 1983
Prickly Pear Creek, MT	Brook/Brown/Rainbow	—	—	—	—	Elser 1968
Rabbit Creek, WY	Cutthroat	—	—	1.4	—	Binns and Eiserman 1979
Raymond Creek, WY	Brook/Cutthroat	—	—	11.0	—	Binns and Eiserman 1979
Right Hand Fork, CO	Greenback Cutthroat	(0.07 to 0.28)	.18/m	(8.94 to 11.13)	10.0	Scarnecchia and Bergeson 1986
Roaring Creek, CO	Greenback Cutthroat	(0.21 to 0.32)	.27/m	(7.46 to 7.91)	7.7	Scarnecchia and Bergeson 1986
Roaring Fork of the Little Snake, WY	Brook	(0.57 to 0.98)	.75/m	12.7	—	Wesche 1980
Rock Creek, WY	Brook/Brown/Rainbow	0.03	—	24.3	—	Remmick 1983
Rose Creek, WY	Cutthroat	—	—	5.6	—	Binns and Eiserman 1979
Sand Creek, WY	Rainbow/Brown	—	—	63.4	—	Binns and Eiserman 1979

(con.)

Table 5 (Con.)

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Sangre de Cristo River, CO	Cutthroat	—	—	(2.6 to 3.0)	2.8	Nehring 1979
Sheep Creek, MT	Rainbow	—	—	4.5	—	Leathe 1980
South Fork Rio Grande, CO	Brown/Rainbow	—	—	(11.4 to 13.0)	12.2	Nehring 1979
South Platte River, CO	Brown/Rainbow	(0.08 to 0.26)	0.18	(0.01 to 7.8)	2.8	Nehring 1979
South Platte River, CO (M. Fk.)	Brown/Rainbow	(>0.10)	—	(10.0 to 20.0)	—	Nehring 1979
St. Louis Creek, CO	Brook/Rainbow	—	—	(1.5 to 3.1)	2.3	Nehring 1983
St. Regis River, MT	Brook/Cutthroat	—	—	2.0	—	Leathe 1980
Sweetwater River, WY	Brown/Rainbow	—	—	3.2	—	Wesche 1980
Taylor Creek, CO	Brown	(1.5 to 3.7/m)	2.4/m	—	—	CDOW 1981
Tenmile Creek, CO	Brook/Rainbow	(0.012 to 0.078/m)	.056/m	(1.6 to 10.5)	5.8	CDOW 1981
Tongue River, WY	Cutthroat/Rainbow	—	—	8.8	—	Binns and Eiserman 1979
Trout Creek, CO	Brook/Brown	(0.01 to 0.04)	.02	(1.2 to 14.3)	5.6	CDOW 1981
Trout Creek, MT	Rainbow	—	—	(6.6 to 37.9)	13.5	Leathe 1980
West Branch of the North Fork of the Little Snake, WY	Cutthroat	(0.20 to 0.39/m)	.27/m	(3.4 to 5.9)	4.6	Wesche 1980
Williams Fork River, CO	Brook/Rainbow	—	—	(0.05 to 0.2)	0.1	Nehring 1979
Willow Creek, UT	Brook/Cutthroat/Rainbow	0.17	—	10.6	—	UDNR 1980
Wind River, WY (E. Fk.)	Cutthroat	—	—	5.7	—	Wesche 1980

Density values listed as #/m, are included as surface area within study areas was not given, only linear distances.

Table 6—Density and standing crop biomass of salmonids in selected streams within the Colorado Plateau ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Beaver Creek, UT	Rainbow	(0.08 to 0.09)	0.085	(10.6 to 11.7)	11.1	UDNR 1980
Beaver Dam Wash, UT	Rainbow	(0.13 to 0.18)	.16	(4.9 to 5.6)	5.3	UDNR 1980
Beaver River, UT	Brown/Rainbow	(0.01 to 0.02)	.015	(1.8 to 5.8)	3.8	UDNR 1980
Calf Creek, UT	Brown	(0.04 to 0.15)	.085	(5.9 to 12.1)	9.0	UDNR 1980
Granite Creek, UT	Brook	0.04	—	2.9	—	UDNR 1980
Indian Creek, UT	Brown/Rainbow	(0.07 to 0.13)	.10	(8.3 to 13.4)	10.8	UDNR 1980
Little Creek, UT	Cutthroat/Rainbow	(0.03 to 0.04)	.035	(2.9 to 3.3)	3.1	UDNR 1980
Lost Creek, UT	Brown	0.02	—	7.8	—	UDNR 1980
Mill Creek, UT	Brown/Rainbow	0.01	—	1.5	—	UDNR 1980
North Fork North Creek, UT	Brown/Rainbow	0.05	—	5.8	—	UDNR 1980
Parawan Creek, UT	Brown/Rainbow	(0.06 to 0.12)	.09	(6.3 to 10.4)	8.4	UDNR 1980
Pine Creek, UT	Rainbow	(0.05 to 0.08)	.065	(5.3 to 6.4)	5.8	UDNR 1980
South Creek, UT	Brown/Cutthroat/Rainbow	0.09	—	9.8	—	UDNR 1980
Summit Creek, UT	Rainbow	(0.02 to 0.03)	.025	(1.0 to 6.2)	3.6	UDNR 1980
Urie Creek, UT	Rainbow	0.18	—	3.6	—	UDNR 1980

Table 7—Density and standing crop biomass of salmonids in selected streams within the Upper Gila Mountain ecoregion

Stream	Species	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$	Source
		Fish/m²		*g/m²*		
Big Bonito Creek, AZ	Apache Trout	(0.31 to 0.40)	0.34	(10.8 to 14.6)	13.0	Rinne 1978
Big Dry Creek, NM	Brown/Gila Hybrid	(0.6 to 0.9)	.7	(23.0 to 23.1)	23.0	McHenry 1986
Iron Creek, NM	Gila	0.2	—	5.0	—	McHenry 1986
Iron Creek (S. Fk.), NM	Gila	0.2	—	4.8	—	McHenry 1986
Main Diamond Creek, NM	Gila	(0.4 to 0.6)	.5	(8.9 to 9.2)	9.1	McHenry 1986
McKenna Creek, NM	Gila	(0.1 to 0.2)	.13	2.6	—	McHenry 1986
McKnight Creek, NM	Gila	(0.3 to 1.1)	.5	(6.3 to 9.0)	7.7	McHenry 1986
South Diamond Creek, NM	Gila	(0.70 to 0.90)	.8	(7.3 to 20.0)	12.4	McHenry 1986
Spruce Creek, NM	Gila	0.21	—	4.8	—	McHenry 1986

Table 8—Descriptive statistics of biomass of trout by ecoregion

Ecoregion	Mean	Standard deviation	n
	g/m^2		
Pacific	2.17	1.97	54
Sierra	8.21	10.60	73
Columbia	3.80	4.44	42
Intermountain	4.03	3.88	22
Rocky Mountain	7.71	9.21	62
Colorado Plateau	6.15	3.12	15
Gila	9.15	6.29	9
Average	5.39	6.63	277

Table 9—Results of the Fisher's LSD test for differences between biomass of trout by ecoregion. The 95 percent confidence intervals (C.I.) were generated around the mean difference between ecoregions

Ecoregion	Lower C.I.	Mean difference	Upper C.I.
		g/m^2	
Rcky-Gila	−8.79	−2.38	4.02
Rcky-Sier	−6.47	−1.82	2.84
Rcky-Colo	−5.04	.62	6.28
Rcky-Intm	−2.18	3.13	8.43
Rcky-Colu	−1.52	3.44	8.40
Rcky-Paci	− .18	4.57	9.33
Gila-Sier	−4.51	.56	5.64
Gila-Colo	−3.01	3.00	9.01
Gila-Intm	− .16	5.51	11.19
Gila-Colu	.46	5.82	11.18*[1]
Gila-Paci	1.78	6.95	12.12*
Sier-Colo	−1.65	2.43	6.53
Sier-Intm	1.35	4.95	8.54*
Sier-Colu	2.19	5.26	8.32*
Sier-Paci	3.67	6.38	9.10*
Paci-Colo	−8.15	−3.95	.25
Paci-Intm	−5.15	−1.44	2.28
Paci-Colu	−4.34	−1.13	2.08
Colu-Colo	−7.26	−2.82	1.62
Colu-Intm	−4.29	− .31	3.67
Intm-Colo	−7.33	−2.51	2.31

[1]*Significant at 0.05 percent.

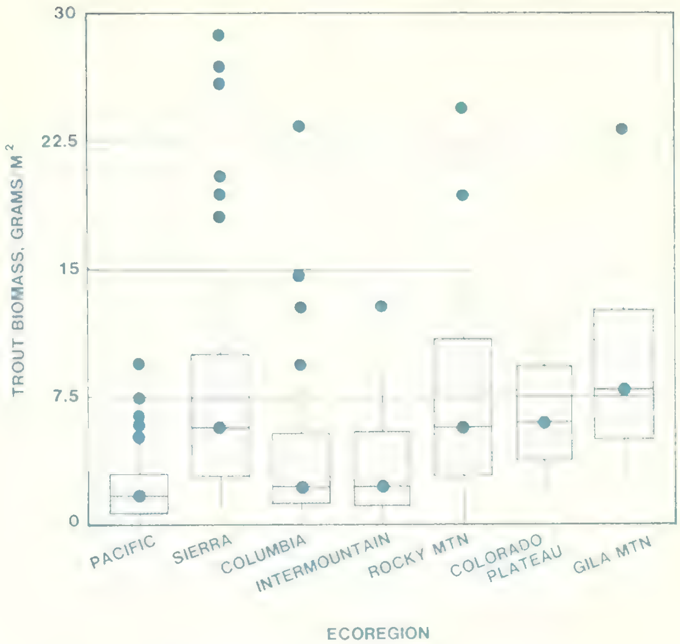

Figure 2—Box plots of trout biomass by ecoregion. Upper and lower sections of boxes represent 75th and 25th percentiles, respectively. White lines within boxes are the median, and circles are outlying data points.

Because of the skewed distribution of the data and apparent heterogeneity of variance, we felt medians were important descriptive statistics. Interestingly, highest median biomass was in the Gila Mountains (7.6 g/m^2), followed by the Colorado Plateau (5.9 g/m^2), Sierra Nevada (5.6 g/m^2), Rocky Mountains (5.4 g/m^2), Intermountain and Columbia (1.8 g/m^2), and Pacific regions (1.6 g/m^2). Box plots of biomass by ecoregion are depicted in figure 2.

In contrast to biomass, density of salmonids in the Western United States was less variable, exhibiting a narrow range of values. Density ranged from 0 to 4.2 fish/m^2 (tables 1-7) and averaged 0.25 fish/m^2 for all sites. The highest densities were in the Rocky Mountain ecoregion (0.55 fish/m^2), followed by the Gila Mountain (0.39 fish/m^2), Pacific (0.29 fish/m^2), Columbia (0.22 fish/m^2), Sierra Nevada (0.16 fish/m^2), Colorado Plateau (0.07 fish/m^2), and Intermountain (0.40 fish/m^2) ecoregions. Descriptive statistics for trout density by ecoregion are shown in table 10. Although the range of density values was far less than those observed for biomass, significant differences between regional trout density were observed (ANOVA F = 3.01). Individual paired t-tests (Fisher's LSD) are given in table 11 and show the unique differences between trout density in each region.

Analysis of medians through box plotting (fig. 3) confirms the narrow range of density values. Medians for all regions were all less than 0.4 fish/m^2, while box height was much less than observed in biomass box plots. Box height represents the spread or range of 50 percent of the data (data between 25th and 75th percentiles). Meaningful comparisons of trout densities were occluded because of smaller sample size and a plethora of measurement units. Additionally, we were unable to ascertain the contribution of juvenile fishes to density measures.

To explore the relationship between trout density and biomass, all data were analyzed both regionally and by pooling all paired data points. After reviewing several scatter plots, least squares linear regression was used with trout density as the independent variable and trout biomass as the dependent variable. Generally, density was not a significant factor in describing regional biomass trends (table 12). In three regions, the Gila Mountain (r^2 = 0.59), Sierra Nevada (r^2 = 0.28), and Columbia (r^2 = 0.17), density of trout contributed at least some information for explaining the variation in trout biomass. In the remaining regions, we concluded that trout density was not a significant factor in explaining trout biomass because the slope of the regression was not significantly different from zero at the 0.05 percent level.

Table 10—Descriptive statistics of density of trout by ecoregion

Ecoregion	Mean	Standard deviation	n
	Fish/m²		
Pacific	0.29	0.29	49
Sierra	.16	.17	61
Columbia	.22	.16	43
Intermountain	.04	.40	39
Rocky Mountain	.55	.67	18
Colorado Plateau	.07	1.12	15
Gila Mountain	.39	.24	9
All	.25	.51	234

Table 11—Results of the Fisher's LSD test for differences between biomass of trout by ecoregion. The 95 percent confidence intervals (C.I.) were generated around the mean difference between ecoregions

Ecoregion	Lower C.I.	Mean difference	Upper C.I.
		g/m²	
Rcky-Gila	−0.08	0.25	0.59
Rcky-Paci	.08	.34	.59*[1]
Rcky-Colu	.14	.41	.67*
Rcky-Intm	.18	.46	.75*
Rcky-Sier	.23	.47	.73*
Rcky-Colo	.20	.51	.81*
Gila-Paci	− .18	.09	.36
Gila-Colu	− .13	.15	.44
Gila-Intm	− .08	.21	.51
Gila-Sier	− .04	.22	.49
Gila-Colo	− .06	.26	.57
Paci-Colu	− .10	.06	.23
Paci-Intm	− .07	.12	.32
Paci-Sier	− .01	.13	.28
Paci-Colo	− .05	.16	.39
Colo-Intm	− .29	.06	.27
Colu-Sier	− .09	.07	.23
Colu-Colo	− .13	.10	.34
Intm-Sier	− .18	.01	.20
Intm-Colo	− .21	.04	.29
Sier-Colo	− .18	.03	.25

[1]*Significant at 0.05 percent.

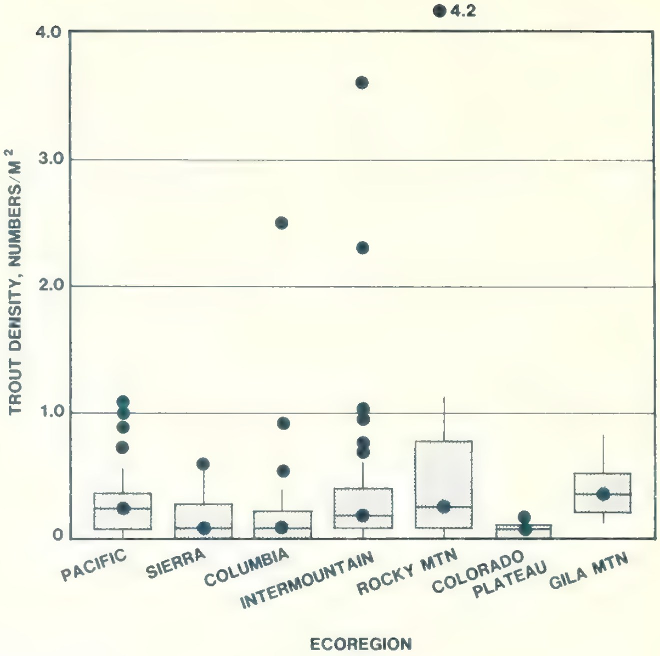

Figure 3—Box plots of trout density by ecoregion. Upper and lower sections of boxes represent 75th and 25th percentiles, respectively. White lines within boxes are the median, and circles are outlying points.

Table 12—Results of least squares linear regression analysis of trout biomass (x) and density (y)

Ecoregion	Equation	[1]r^2	P
Pacific	$y = 1.70 + 1.59 (x)$	0.05	0.09
Sierra	$y = 2.39 + 35.63 (x)$	.28	.001*[2]
Columbia	$y = 2.33 + 4.06 (x)$	.17	.01*
Intermountain	$y = 2.64 + 5.46 (x)$	.04	.34
Rocky Mountain	$y = 5.64 + 0.48 (x)$	.01	.79
Colorado Plateau	$y = 5.07 + 7.60 (x)$	.24	.06
Gila Mountain	$y = 1.09 + 20.25 (x)$	.59	.01*
All	$y = 4.63 + 3.01 (x)$	.02	.03

[1]r^2 = coefficient of determination.
[2]*Significant at 0.05 percent.

Analysis by species indicated small but significant differences in the level of density/biomass of different salmonids in the Western United States. Nine trout species—Apache, brook, brown, bull, cutthroat, Gila, golden, rainbow, and mixed (streams occupied by more than one species of trout)—were included in the analysis. Analysis of variance led us to reject the null hypothesis "no difference in biomass between species of trout in the Western United States" ($F = 2.28$, $p < 0.01$). Similarly, density was also found to be significantly different at the 0.01 percent level ($F = 2.42$). Results of the density/biomass species comparison using the Fisher's LSD test are provided in tables 13 and 14.

To assist biologists in planning and managing of fishery resources, we developed a series of biomass curves for each ecoregion (figs. 4-9) except Gila Mountain, which we omitted because of small sample size. Although certainly not all encompassing, these curves will allow biologists to compare a particular stream on a regional perspective. Thus, a biologist can ascertain the biomass of a stream and make inferences to its relative value as a fishery as compared to other streams within the same ecoregion. From a planning standpoint, such information is invaluable. However, other factors such as economics, esthetics, and sociological and political factors should also be considered before management decisions are made.

Table 13—Results of the Fisher's LSD test for differences between density of trout species in the Western United States. The 95 percent confidence intervals were generated around the mean difference between species

Species	Lower C.I.	Mean difference	Upper C.I.
		Fish/m²	
Brwn-Goln	−0.30	0.29	0.90
Brwn-Rain	.02	.34	.65*[1]
Brwn-Gila	− .05	.34	.74
Brwn-Apac	− .44	.36	1.17
Brwn-Cutt	.12	.41	.70*
Brwn-Brok	.15	.48	.80*
Brwn-Bull	.36	.44	1.25*
Brwn-Mixd	.26	.54	.82*
Goln-Rain	− .52	.04	.60
Goln-Gila	− .56	.04	.65
Goln-Apac	− .87	.06	.99
Goln-Cutt	− .43	.11	.66
Goln-Bull	− .78	.14	1.08
Goln-Brok	− .38	.18	.74
Goln-Mixd	− .30	.24	.78
Rain-Apac	− .75	.02	.81
Rain-Cutt	− .12	.07	.27
Rain-Bull	− .67	.11	.88
Rain-Brok	− .10	.14	.38
Rain-Mixd	.01	.21	.39*
Gila-Apac	− .79	.02	.83
Gila-Cutt	− .23	.07	.38
Gila-Bull	− .71	.10	.92
Gila-Brok	− .19	.13	.47
Gila-Mixd	− .09	.20	.50
Apac-Cutt	− .72	.05	.82
Apac-Bull	− .99	.08	1.15
Apac-Brok	− .66	.11	.89
Apac-Mixd	− .58	.17	.94
Cutt-Bull	− .74	.03	.80
Cutt-Brok	− .13	.06	.27
Cutt-Mixd	.00	.13	.26
Bull-Brok	− .74	.03	.81
Bull-Mixd	− .66	.09	.86
Brok-Mixd	− .12	.06	.25

[1]*Significant at 0.05 percent.

Table 14—Results of the Fisher's LSD test for differences between biomass of trout species in the Western United States. The 95 percent confidence intervals (C.I.) were generated around the mean difference between species

Species	Lower C.I.	Mean difference	Upper C.I.
		g/m²	
Brwn-Apac	−17.0	−1.45	14.11
Brwn-Goln	−8.05	3.55	15.15
Brwn-Mixd	− .59	4.81	10.22
Brwn-Gila	−2.67	4.92	12.52
Brwn-Rain	1.05	7.19	13.33*[1]
Brwn-Brok	2.19	8.37	14.56*
Brwn-Cutt	3.15	8.74	14.33*
Brwn-Bull	−6.56	9.05	24.62*
Goln-Apac	−22.9	−5.00	12.97
Goln-Mixd	−9.22	1.26	11.75
Goln-Gila	−10.4	1.37	13.13
Goln-Rain	−7.24	3.64	14.53
Goln-Brok	−6.08	4.82	15.73
Goln-Cutt	−5.38	5.19	15.77
Goln-Bull	−12.5	5.50	23.47
Rain-Apac	−23.7	−8.64	6.39
Rain-Goln	−14.5	−3.64	7.23
Rain-Mixd	−6.00	−2.38	1.23
Rain-Gila	−8.72	−2.27	4.17
Rain-Brok	−3.52	1.17	5.88
Rain-Cutt	−2.33	1.54	5.43
Rain-Bull	−13.2	1.85	16.89
Gila-Apac	−22.1	−6.37	9.32
Gila-Mixd	−5.86	− .11	5.64
Gila-Brok	−3.03	3.45	9.94
Gila-Cutt	−2.10	3.82	9.74
Gila-Bull	−11.5	4.13	19.82
Apac-Mixd	−8.49	6.26	21.01
Apac-Brok	−5.23	9.82	24.88
Apac-Cutt	−4.63	10.19	25.01*
Apac-Bull	−10.5	10.50	31.25*
Cutt-Mixd	−6.51	−3.93	1.36*
Cutt-Brok	−4.32	− .37	3.58
Cutt-Bull	−14.5	.31	15.13
Brok-Mixd	−7.25	−3.56	.13
Brok-Bull	−14.4	.67	15.73
Bull-Mixd	−18.9	−.31	14.51

[1]*Significant at 0.05 percent.

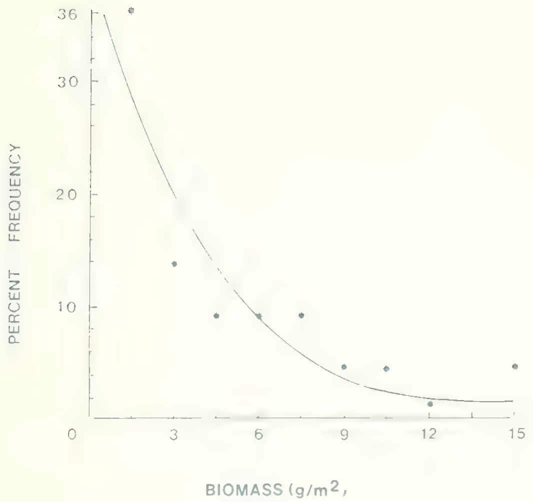

Figure 4—Trout biomass-frequency distribution curve for streams in the Intermountain Sagebrush ecoregion.

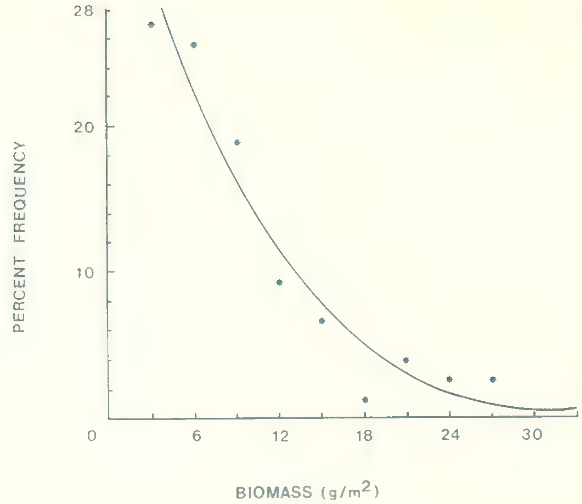

Figure 6—Trout biomass-frequency distribution curve for streams in the Sierra Nevada Forest ecoregion.

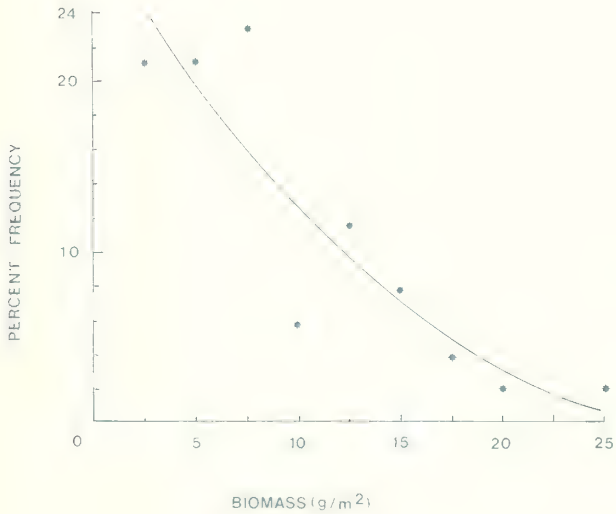

Figure 5—Trout biomass-frequency distribution curve for streams in the Rocky Mountain Forest ecoregion.

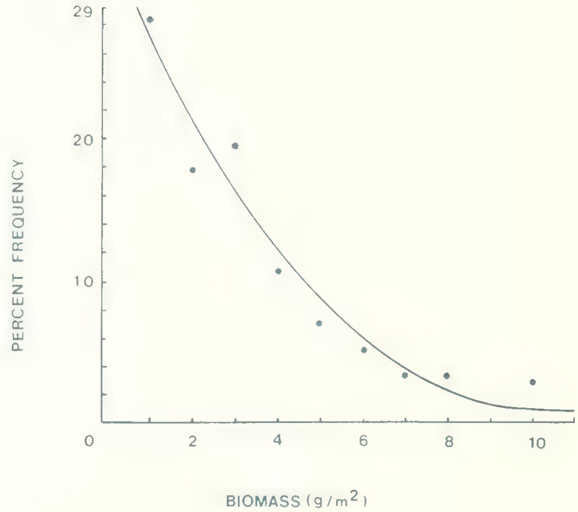

Figure 7—Trout biomass-frequency distribution curve for streams in the Pacific Forest ecoregion.

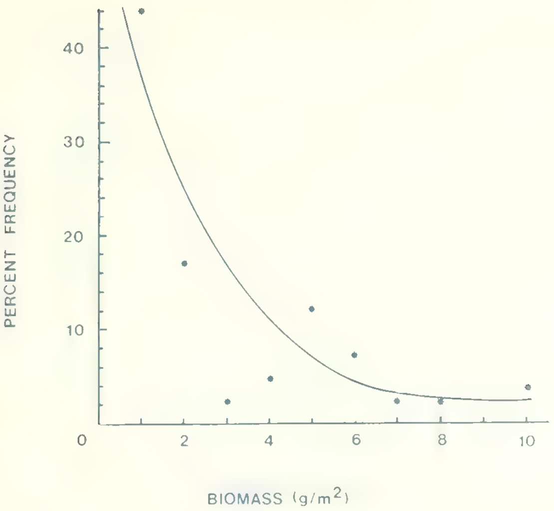

Figure 8—Trout biomass-frequency distribution curve for streams in the Colorado Plateau ecoregion.

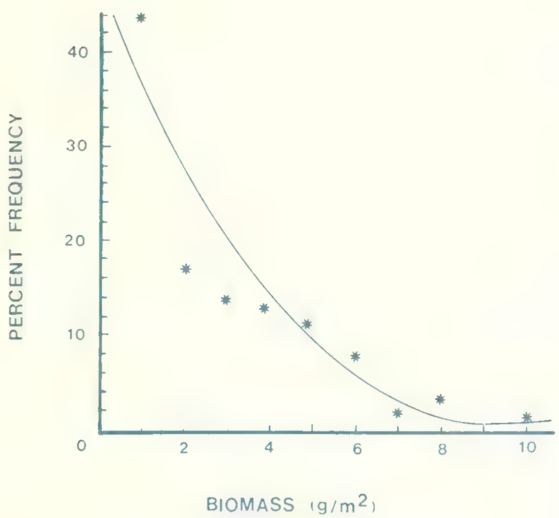

Figure 9—Trout biomass-frequency distribution curve for streams in the Columbia Forest ecoregion.

DISCUSSION

The data sets showed that significant interregional differences existed between the density and biomass of trout in the Western United States. Although it is difficult to speculate why these differences occurred without accompanying habitat and environmental data, several explanations are plausible. On the macro level, interregional differences between the biomass and density of trout populations are probably best explained by large shifts in patterns of general environmental conditions. Platts (1982) found that in the South Fork Salmon River, ID, geology, climate, and hydraulics interacted to influence fish population. Such reasoning reflects the current effort to build physical environment-fish population classification models (Frissel and others 1986; Lotspeich and Platts 1979).

Another possible explanation for the observed differences in trout populations is variations in microhabitat potential. Salmonid populations are limited both temporally and spatially (Hall and Knight 1981) by a variety of physical, chemical, and biological factors. Hynes (1972) determined that the most important abiotic factors controlling survival in fluvial fish habitats are water temperature, water velocity, escape cover, and discharge regime. Lewis (1969) and Rinne (1982) identified pool volume as significantly correlated to trout populations in Montana and New Mexico, respectively. Discharge was successfully used to explain the biomass of brook trout in Michigan (Latta 1965), Atlantic salmon in Maine (Havey and Davis 1970), and brown trout in Wisconsin (White 1975). A number of studies have identified cover as limiting to trout populations (Binns and Eiserman 1979; Hunt 1974; Wesche 1980). Other authors have discovered relationships between trout populations and depth (Stewart 1970), invertebrate biomass (Murphy 1979), and large organic debris (Sedell and others 1982). Results of these studies indicate that seldom does a single factor limit fish populations. Rather, it is a series of variables that combined operate to positively or negatively influence a population. While it is evident that a single factor such as flooding may temporarily limit a given population, it is the combination of environmental variables through time and space that determines the ultimate success or failure of a population.

Pooling all available data by species showed few significant trends. Density and biomass of brown trout were significantly greater than those of brook, bull, cutthroat, and rainbow trout. Whether or not this observation is attributable to the brown trout's aggressive behavior is speculative.

Streams occupied by multiple species of trout (sympatric) had densities and biomasses that were not significantly different from those streams occupied by single species (allopatric). These results indicate that various assemblages of salmonids may have an equal ability to occupy an available stream habitat. Although interspecific competition between species may determine the relative contributions of individual species to the composition of a population, it appears that regardless of species and in the absence of human perturbations, trout will occupy a habitat to its potential carrying capacity.

Trout density was generally not a significant factor in explaining regional biomass trends. These results were not particularly surprising because in most regions we had no idea of the contribution of juvenile age classes to the population estimates. Although juvenile fishes typically contribute only about 10 percent of the biomass by weight, their contribution to density measurements is usually far greater (Allen 1951). Additionally, because juvenile trout are subject to high mortality rates, thereby fluctuating greatly in abundance, it may not be possible to develop predictive equations concerning biomass and density. Further study is necessary to allow complete understanding of this relationship.

The development of regional biomass curves represents an important step for fisheries managers. By comparing a stream to other streams in a particular region, it will be possible to make inferences to that stream's productivity. If, for example, a stream in the Pacific Forest ecoregion had a biomass of 10.0 g/m^2, it would be important to give that stream special management considerations, as streams with that level of biomass occurred less than 10 percent of the time (fig. 7).

In conclusion, analysis of trout density and biomass for seven ecoregions of the Western United States indicates that regional differences are apparent. Although several reasons for these differences are identified (geoclimatic differences, microhabitat potential), the authors feel that without additional quantitative environmental and habitat data, development of cause-and-effect theories would be speculative. Rather, we would prefer to let biologists, intimately familiar with conditions in the respective ecoregions, draw their own conclusions. The authors plan to continue expanding the existing data base. Additional data will increase the reliability of the analysis and lead to greater confidence among relationships.

We feel that this document is important as background for management decisions. The identification and protection of high productivity stream systems are important in multiple-use Federal agencies. Similarly, enhancement of degraded streams is also critical. A regional perspective will allow managers to make better management decisions, benefitting both society and the environment.

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Density and biomass of resident salmonids in 313 streams in the Western United States were analyzed for tendencies and significant differences. A regional perspective was used for analysis by dividing the 11 Western States into seven separate physiographic ecoregions. Trout density was less variable than trout biomass. Density ranged from 0 to 4.2 fish/m^2, and averaged 0.25 fish/m^2, while biomass varied between 0 and 81.9 g/m^2, and averaged 5.4 g/m^2. Generally, trout density was highest in the Rocky Mountain ecoregion, while trout biomass was greatest in the Sierra Nevada and Upper Gila Mountain ecoregions. The relationship between trout biomass and density was generally nonsignificant. Biomass data were used to develop a series of regional biomass-frequency curves for use in planning and management activities.

KEYWORDS: production, carrying capacity, salmonids, population estimates, ecoregion

INTERMOUNTAIN RESEARCH STATION

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Beaver in Western North America: An Annotated Bibliography, 1966 to 1986

Dean E. Medin
Kathryn E. Torquemada

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THE AUTHORS

DEAN E. MEDIN is a research wildlife biologist with the Intermountain Research Station at the Forestry Sciences Laboratory in Boise, ID. He earned a B.S. degree in forest management from Iowa State University in 1957, an M.S. degree in wildlife management from Colorado State University in 1959, and a Ph.D. degree in range ecosystems from Colorado State University in 1976.

KATHRYN E. TORQUEMADA is a biological technician with the Intermountain Research Station at the Forestry Sciences Laboratory in Boise, ID. She earned a B.S. degree in wildlife management from Humboldt State University in 1982.

RESEARCH SUMMARY

This annotated bibliography of published literature on the beaver (*Castor canadensis*) contains 206 references to both technical and popular articles and covers a period from 1966 to 1986. Emphasis is on the Western United States and Canada. A subject index is keyed to an alphabetical list of authors. The purpose of the bibliography is to provide a working tool for natural resource specialists, land-use planners, and others charged with managing beavers and their habitats.

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Intermountain Research Station
324 25th Street
Ogden, UT 84401

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INTRODUCTION

Of the wild mammals associated with riparian-aquatic habitats, beavers (*Castor canadensis*) bring about the most extensive changes in their environment. Their activities have pronounced effects upon the ecology and management of not only the immediate area but of downstream habitats as well. In some cases the status of the beaver is unclear; activities may at the same time be both beneficial and detrimental. Because of this duality, the beaver in some areas presents difficult management challenges.

This annotated bibliography is a review of literature on the beaver in Western North America published from 1966 to 1986. Emphasis is on the Western United States and Canada in recognition of regional differences in beaver habitats and regional problems in beaver management. Inclusion of references solely on the basis of geography was somewhat arbitrary. This bibliography was compiled to provide a working tool for use by natural resource specialists, land-use planners, and others charged with managing beavers and their habitats.

Only published information that is generally available is included in this bibliography. References range from technical reports to popular articles and include both methodological and substantive papers. The annotations provide a general idea of the information and results contained in each publication. Some annotations provide only that information contained in broad-based articles that are relevant to this bibliography. The annotations are not intended to be abstracts.

The organization of the bibliography was purposely kept simple. It is arranged alphabetically by author with a number assigned to each entry. To make the bibliography more useful, a subject index is provided. The alphabetical subject index lists the numbers of references, keyed to author, for each subject heading.

The method of citation is in general accordance with the style recommended by the American National Standards Institute (ANSI Z39.29-1977). Preface pages and references to illustrative materials have been omitted. Authors' names are listed as they appear on the original copy of the reference.

Several abstracting publications, books, periodicals, monographs, and bibliographies were useful in locating reference material. Some of these and other important sources for locating additional or earlier references on beavers are listed below.

Avery, Ed L. 1983. A bibliography of beaver, trout, wildlife, and forest relationships with special references to beaver and trout. Tech. Bull. 137. Madison, WI: Wisconsin Department of Natural Resources. 23 p.

Biological Abstracts. 1966-1986. Philadelphia, PA: Biosciences Information Service.

Black, Hugh C.; Taber, Richard D. 1977. Mammals in western coniferous forest ecosystems: an annotated bibliography. Bull. 2. Seattle, WA: University of Washington, U.S./International Biological Program, Coniferous Forest Biome. 199 p.

Canadian Journal of Zoology. 1966-1986. Ottawa, ON: The National Research Council of Canada.

Hill, Edward P. 1982. Beaver. In: Chapman, Joseph A.; Feldhamer, George A., eds. Wild mammals of North America: biology, management, and economics. Baltimore, MD: Johns Hopkins University Press: 256-281.

Hodgdon, Harry E.; Larson, Joseph S. 1980. A bibliography of the recent literature on beaver. Res. Bull. 665. Amherst, MA: University of Massachusetts, Agricultural Experiment Station. 128 p.

Jenkins, Stephen H.; Busher, Peter E. 1979. *Castor canadensis*. Mammalian Species 120. Provo, UT: The American Society of Mammalogists. 8 p.

Journal of Mammalogy. 1966-1986. Provo, UT: The American Society of Mammalogists.

Journal of Wildlife Management. 1966-1986. Bethesda, MD: The Wildlife Society.

Wildlife Abstracts. 1966-1986. Fort Collins, CO: U.S. Department of the Interior, Fish and Wildlife Service.

Yeager, Lee E.; Hay, Keith G. 1955. A contribution toward a bibliography on the beaver. Tech. Bull. 1. Denver, CO: Colorado Game and Fish Department. 103 p.

BIBLIOGRAPHY

1. Aleksiuk, Michael. 1968. Scent-mound communication, territoriality, and population regulation in beaver (*Castor canadensis* Kuhl). Journal of Mammalogy. 49(4): 759-762.

After observations on the Mackenzie Delta, Northwest Territories, Canada, Aleksiuk hypothesized that scent mound systems function as a means of communication among beaver from adjacent colonies and between established colonies and the floating population. The system appears to be a mechanism of self-regulation that limits the population before food becomes a major limiting factor.

2. Aleksiuk, Michael. 1970. The function of the tail as a fat storage depot in the beaver (*Castor canadensis*). Journal of Mammalogy. 51(1): 145-148.

The author discusses the seasonal pattern of tail fat and its role as a storage of energy reserves on specimens collected on the Mackenzie Delta, Northwest Territories, Canada.

3. Aleksiuk, Michael. 1970. The seasonal food regime of arctic beavers. Ecology. 51(2): 264-270.
This study on the Mackenzie Delta, Northwest Territories, Canada, examined the seasonal variation in food of the beaver. Leaves and growing tips of willows were the main food items in July and August. The remainder of the year beaver preferred a diet of willow bark, poplar, and alder. The northern beaver has adapted to seasonal variation in protein availability by utilizing high-protein willow leaves almost exclusively when they are available.

4. Aleksiuk, Michael; Cowan, Ian McTaggart. 1969. Aspects of seasonal energy expenditure in the beaver (*Castor canadensis* Kuhl) at the northern limit of its distribution. Canadian Journal of Zoology. 47(4): 471-481.
The study in the Mackenzie Delta, Northwest Territories, showed that a winter weight loss characterized immature animals. Fat was deposited in the autumn, maintained during the winter, and mobilized in the spring. Thyroid gland weights were high in the summer and low in the winter. Metabolic energy expenditure was high during the summer and low during the winter. This annual pattern is an inherent property of northern beavers.

5. Aleksiuk, Michael; Cowan, Ian McTaggart. 1969. The winter metabolic depression in arctic beavers (*Castor canadensis* Kuhl) with comparisons to California beavers. Canadian Journal of Zoology. 47(5): 965-979.
No major seasonal changes occurred in California beavers kept under Vancouver climatic conditions, but arctic beavers kept under the same conditions showed a growth cessation, a 40 percent reduction in food intake, and a depression in the 131PBI conversion ratio during the winter. The authors concluded that northern beavers possess a winter metabolic depression induced by decreasing light intensity in the autumn.

6. Allen, Arthur W. 1983. Habitat suitability index models: beaver. Fort Collins, CO: U.S. Department of the Interior, Fish and Wildlife Service. 20 p.
Habitat preferences are described along with a mathematical model designed to provide information for use in impact assessment and habitat management activities. This updates the model in the original publication dated September 1982.

7. Allred, Morrell. 1980. A re-emphasis on the value of the beaver in natural resource conservation. Journal of the Idaho Academy of Science. 16(1): 3-10.
The author looked at sedimentation, storage of water, and increased diversity of beaver ponds and communities on three tributaries of the South Fork of the Snake River near the Idaho-Wyoming border. Water impoundments by beavers provided increased surface area, water current deceleration, regulation of stream flow, a water reservoir, filter for low density particulates, and a greater diversity of wildlife habitat.

8. Allred, Morrell. 1981. The potential use of beaver population behavior in beaver resource management. Journal of the Idaho Academy of Science. 17(1): 14-24.
Allred discusses the ratio of transient to resident beavers, mortality within populations, and effects of high water on their movement on two tributaries of the South Fork Snake River in western Wyoming.

9. Allred, Morrell. 1986. Beaver behavior. Happy Camp, CA: Naturegraph Publishers, Inc. 110 p.
The author discusses beaver history, physical characteristics, life history, behavior, and management.

10. Apple, Larry L. 1983. The use of beavers in riparian/aquatic habitat restoration in a cold desert, gully-cut stream system: a case history. In: Whaley, R., ed. Proceedings, 18th annual meeting Colorado-Wyoming Chapter, American Fisheries Society; 1983 March 2-3; Laramie, WY. [Publisher and city unknown]: 29-35.
This study sought to use "natural" systems and beaver reintroduction to restore riparian habitat on two perennial streams in southwestern Wyoming. The newly built dams were trapping sediment, reducing stream velocity, and locally elevating the water table, thus allowing reestablishment of willow and other riparian plants.

11. Apple, Larry L. 1984. Riparian habitat restoration in cold desert, gully-cut stream systems: an innovative, cost effective, ecological approach. In: Transactions of the 49th North American wildlife and natural resources conference; 1984 March 23-28; Boston, MA. Washington, DC: Wildlife Management Institute [Unpaged]. Poster Session.
Study areas in overgrazed areas in the Rock Springs, WY, district helped determine if beaver could assist the riparian recovery process. Beaver activity reduced the ability of the stream to transport sediment by reducing the effective slope of the stream channel.

12. Apple, Larry L. 1985. Riparian habitat restoration and beavers. In: Johnson, R. Roy; Ziebell, Charles, D.; Patton, David R.; Ffolliott, Peter F.; Hamre, R. H., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses: first North American riparian conference; 1985 April 16-18; Tucson, AZ. Gen. Tech. Rep. RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 489-490.
This study in southwestern Wyoming sought to determine if both materials and beaver could be supplied or relocated into marginal habitats with resulting habitat improvement. At the end of 3 years, results showed promise.

13. Apple, Larry L.; Smith, Bruce H.; Dunder, James D.; Baker, Bruce W. 1984. The use of beavers for riparian/aquatic habitat restoration of cold desert, gully-cut stream systems in southwestern Wyoming. In: Proceedings, American Fisheries Society/ Wildlife Society joint chapter meeting; 1984

February 8-10; Logan, UT. [Publisher and city unknown]: 123-130.
Several study projects in the Rock Springs, WY, district resulted in development of techniques for restoring and reestablishing degraded riparian and aquatic habitats. Beaver were reintroduced to fenced study areas and returned on their own to unfenced areas. The newly built beaver dams are trapping sediment, reducing stream velocity, locally elevating the water table, and reducing the effects of seasonally fluctuating water table levels.

14. Avery, Ed L. 1983. A bibliography of beaver, trout, wildlife, and forest relationships with special references to beaver and trout. Tech. Bull. 137. Madison, WI: Wisconsin Department of Natural Resources. 23 p.
Emphasis is on the Midwestern and Eastern United States, but other important references are included.

15. Bailey, Theodore N. 1981. Characteristics, trapping techniques, and views of trappers on a wildlife refuge in Alaska. In: Chapman, J. A.; Pursley, D., eds. Proceedings, worldwide furbearer conference; 1980 August 8-11; Frostburg, MD. Frostburg, MD: Worldwide Furbearer Conference, Inc.: 1904-1918.
Questionnaires given to persons wishing to trap on Alaska's Kenai Penninsula asked about their experience, techniques and views of trapping on the refuge, and any impacts it might have. Outdoor experience was the main reason for trapping, and most trappers trapped for land as well as aquatic furbearers. The majority of trappers indicated they would support additional regulations or closed areas to protect furbearers.

16. Bailey, Theodore N. 1981. Factors influencing furbearer populations and harvest on the Kenai National Moose Range, Alaska. In: Chapman, J. A.; Pursley, D., eds. Proceedings, worldwide furbearer conference; 1980 August 8-11; Frostburg, MD. Frostburg, MD: Worldwide Furbearer Conference, Inc.: 249-272.
Discusses the impact that natural factors have on furbearers, such as the 1964 earthquake, wildfires, overbrowsing of aspen by moose, and increased lynx harvest. Two methods were used to document changes in population levels and harvest rates: comparison of annual furbearer harvests and success rates per trapping permit holder; and comparison of beaver population estimates for different periods and habitats. Factors affecting beaver harvest on the refuge include fur prices, local economic conditions, and trapper experience and technique. Predation on beaver does not appear to be significant.

17. Bartlett, Des; Bartlett, Jen. 1974. Nature's aquatic engineers: beavers. National Geographic. 145(5): 716-732.
A husband-and-wife team studied beaver habits on Granite Creek in Wyoming. They discuss beaver life history.

18. Baskin, Jon Alan. 1974. Small vertebrates of the Bidahochi Formation, northeastern Arizona. Journal of the Arizona Academy of Sciences. 9(Suppl.) :35.
Beaver fossils were one of many small vertebrates found in middle Pliocene sediments from White Cone, Navajo County, AZ.

19. Baxter, R. M. 1977. Environmental effects of dams and impoundments. Annual Review of Ecological Systems. 8: 255-283.
Baxter covers morphology and physical and chemical limnology of artificial lakes, biology of reservoir ecosystems, and downstream effects of impoundments.

20. Bergstrom, Dorothy. 1985. Beavers: biologists "rediscover" a natural resource. Forestry Research West. [Fort Collins, CO]: U.S. Department of Agriculture, Forest Service; October: 1-5.
Researchers and land managers are looking at the beneficial role of beavers in regulating water movement, sediment, and streamside vegetation within watersheds in the Pacific Northwest.

21. Beschta, Robert L. 1979. Debris removal and its effects on sedimentation in an Oregon Coast Range stream. Northwest Science. 53(1): 71-77.
The removal of large organic debris resulted in accelerated downcutting of previously stored sediments. As a result, turbidity and suspended sediment levels increased during several storms. Streamflow eroded more than 5,000 m^3 of sediment along a 250-m reach the first winter after debris removal.

22. Best, Troy L. 1971. Notes on the distribution and ecology of five eastern New Mexico mammals. Southwestern Naturalist. 16(2): 210-211.
Two beaver skulls were collected in Union County, NM, in March 1967. This was the first record of occurrence in the Cimarron River of New Mexico.

23. Bilby, Robert E. 1981. Role of organic debris dams in regulating the export of dissolved and particulate matter from a forested watershed. Ecology. 62(5): 1234-1243.
In an experimental approach, all organic debris dams were removed from a 175-m section of second-order stream, just above a gauging weir. Dam removal brought about a 6 percent increase in the export of dissolved matter and a 500 percent increase in the export of both fine particulate and coarse particulate matter.

24. Bilby, Robert E.; Likens, Gene E. 1980. Importance of organic debris dams in the structure and function of stream ecosystems. Ecology. 61(5): 1107-1113.
Organic debris dams are extremely important components of the small-stream ecosystem. They retain organic matter within the system, thereby allowing it to be processed into finer size fractions in headwater tributaries rather than transported downstream in a coarse particulate form.

25. Black, Hugh C.; Taber, Richard D. 1977. Mammals in western coniferous forest ecosystems: an annotated bibliography. Bull. 2. Seattle, WA: University of

Washington, U.S./International Biological Program, Coniferous Forest Biome. 199 p.
The bibliography contains references on beaver.

26. Blair and Ketchums Country Journal. 1983. Beavers enlisted by BLM. Blair and Ketchums Country Journal. 10: 35.
The U.S. Department of the Interior, Bureau of Land Management, has enlisted beavers to help restore eroded banks along Muddy Creek and its tributary streams in Wyoming. The effects of the beavers' work are already evident. Erosion has been reduced, new vegetation is appearing along streams, the water table is rising, new marsh areas are developing, and fish and wildlife habitat is improving.

27. Boddicker, Major L. 1978. Trapping in the footsteps of mountain men (part 1). Colorado Outdoors. 27(1): 32-35.
Boddicker talks about his beaver trapping experiences in Colorado.

28. Boddicker, Major L. 1978. Trapping in the footsteps of mountain men (part 2). Colorado Outdoors. 27(2): 30-33.
The author discusses trapping techniques he uses.

29. Boddicker, Major L. 1978. Trapping in the footsteps of mountain men (part 3). Colorado Outdoors. 27(3): 36-37.
The author relates what happened to his trapping grounds and the beaver lodges after 3 months of drought and cold.

30. Boyce, Mark S. 1981. Beaver life-history responses to exploitation. Journal of Applied Ecology. 18(3): 749-753.
Boyce studied an exploited beaver population along the Chena River near Fairbanks, AK, and an unexploited beaver population on Birch Creek in the Yukon River drainage. He was testing the theory on the evolution of life histories that optimal reproductive effort varies with changing survivorship schedules. He compared the demographic structure and life history characteristics of these two populations.

31. Boyce, Mark S. 1981. Habitat ecology of an unexploited population of beavers in interior Alaska. In: Chapman, J. A.; Pursley, D., eds. Proceedings, worldwide furbearer conference; 1980 August 8-11; Frostburg, MD. Frostburg, MD: Worldwide Furbearer Conference, Inc.: 155-186.
The spacing pattern of beaver colonies along Birch Creek (Yukon River drainage) was studied relative to the habitat surrounding each colony site. The author used discriminant analysis, multiple regression, and canonical correlation.

32. Brayton, D. Scott. 1984. The beaver and the stream. Journal of Soil and Water Conservation. 39(2): 108-109.
Beaver were introduced to two severely eroded streams in southwestern Wyoming to help restore riparian habitat, stabilize streambanks, and collect sediment. The results after 3 years were proving favorable.

33. Brazell, Ricky E.; Workman, Gar W. 1977. A preliminary survey on beaver (*Castor canadensis*) in Canyonlands National Park, Utah. Encyclia. 54(1): 25-27.
A survey in 1976 examined current abundance and distribution of beaver in the park and the use beaver made of tamarisk (*Tamarix pentandra*). No evidence of tamarisk use was found. Beaver do not appear to be threatened by the tamarisk invasion of willow (*Salix* spp.)

34. Buech, Richard R. 1985. Beaver in water impoundments: understanding a problem of water-level management. In: Knighton, M. Dean, compiler. Water impoundments for wildlife: a habitat management workshop; 1982 August 31-September 2; Bemidji, MN. Gen. Tech. Rep. NC-100. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 95-105.
Reviews the natural history of beaver, their habitat requirements, the problems they cause in impoundments, and why those problems occur. The author offers some potential solutions.

35. Burris, Oliver E.; McKnight, Donald E. 1973. Game transplants in Alaska. Wild. Tech. Bull. 4. Juneau, AK: Alaska Department of Fish and Game. 57 p.
Beaver transplants have occurred since 1925, usually resulting in harvestable populations.

36. Bush, Albert O.; Samuel, W. M. 1978. The genus *Travassosius* Khalil, 1922 (Nematoda, Trichostrongyloidea) in beaver, *Castor* spp.: a review and suggestion for speciation. Canadian Journal of Zoology. 56(7): 1471-1474.
Beaver collected in east-central Alberta were infected with a species of *Travassosius*. One suggestion is that *T. americanus* in *Castor canadensis* is the ancestral stock and that *T. rufus* has evolved following allopatric evolution of *C. fiber*.

37. Bush, Albert O.; Samuel, W. M. 1981. A review of helminth communities in beaver (*Castor* spp.) with a survey of *Castor canadensis* in Alberta, Canada. In: Chapman, J. A.; Pursley, D., eds. Proceedings, worldwide furbearer conference; 1980 August 8-11; Frostburg, MD. Frostburg, MD: Worldwide Furbearer Conference, Inc.: 678-689.
An examination of 86 beaver from Alberta, Canada, for helminth fauna was compared to that of beaver from other Nearctic (*C. fiber*) and Palearctic regions.

38. Busher, P. E. 1983. Interactions between beavers in a montane population in California. Acta Zoologica Fennica. 174: 109-110.
Dominant-submissive and neutral interactions between members of a beaver population in the central Sierra Nevada were studied between 1977 and 1980. Kits had the highest frequency of interactions, while adults had the

lowest. Older animals of both sexes received more interaction than they initiated. Interaction was generally directed from younger animals toward older.

39. Busher, P. E.; Jenkins, S. H. 1985. Behavioral patterns of a beaver family in California. Biology of Behavior. 10(1): 41-54.

Behavioral patterns of beavers were studied at Sagehen Creek, Nevada County, CA, from 1977 to 1979. A cluster analysis revealed age class, sex, and seasonal differences in behavior between individual family members.

40. Busher, Peter E.; Warner, Randall J.; Jenkins, Stephen H. 1983. Population density, colony composition, and local movements in two Sierra Nevadan beaver populations. Journal of Mammalogy. 64(2): 314-318.

Beaver were trapped from May through September 1974 and 1975 at Little Valley and from May through September at Sagehen Creek, CA. The authors demonstrate that social organization of beavers may be more variable than is often assumed.

41. Call, Mayo White. 1966. Beaver pond ecology and beaver-trout relationships in southeastern Wyoming. Laramie, WY: University of Wyoming; Wyoming Game and Fish Commission. 296 p.

The author presents findings on the effects of beaver on water storage, trout habitat, and the water table on the Pole Mountain District of the Medicine Bow National Forest in southeastern Wyoming. Field investigations conducted between 1960 and 1964 show that beaver are of prime importance to the brook trout fishery.

42. Clifford, Hugh F. 1978. Descriptive phenology and seasonality of a Canadian brown-water stream. Hydrobiologia. 58(3): 213-231.

The maximum impounding effect of beaver dams in September is one of the important phenological events of the three ice-free seasons in a brown-water stream in west-central Alberta.

43. Collins, Thomas C. 1976. Stream flow effects on beaver populations in Grand Teton National Park. In: Proceedings, first conference on scientific research in the National Parks; 1976 November 9-13; New Orleans, LA. Arlington, VA: American Institute of Biological Sciences: Series 5, Vol. 1: 349-352.

The objectives of this study (part of a larger investigation) were to assess the influence of stream flow regimes on beaver population abundance, distribution, and movement. Dramatic population movements occurred at low water levels. Dwelling abandonment at high water was not uncommon.

44. Cowell, Daryl W. 1984. The Canadian beaver, *Castor canadensis*, as a geomorphic agent in karst terrain. The Canadian Field-Naturalist. 98(2): 227-230.

In areas underlain by carbonate bedrock such as limestone or dolomite, surface waters may be captured by underground stream channels creating special problems for the beaver.

45. Craun, Gunther F. 1979. Waterborne outbreaks of giardiasis. In: Jakubowski, W.; Hoff, J. C., eds. Waterborne transmission of giardiasis: Proceedings of a symposium; 1978 September 18-20; Cincinnati, OH. Cincinnati, OH: U.S. Environmental Protection Agency, Health Effects Research Laboratory: 127-149.

Beavers may have been the source of a *Giardia* spp. outbreak in the Uinta Mountains of Utah. Three beavers were found to be infected with *Giardia* cysts at an outbreak in Camas, WA.

46. Crawford, John S. 1978. The subarctic beaver. Alaska. 44: 40-41.

The author observed a beaver family preparing for winter in a remote area of Mount McKinley National Park, AK.

47. Crouch, Glenn L. 1979. Long-term changes in cottonwoods on a grazed and an ungrazed plains bottomland in northeastern Colorado. Res. Note RM-370. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 4 p.

Numbers of cottonwood trees declined between 1961 and 1978. Water management, grazing by livestock and deer, plant competition on the ungrazed area, and beaver-felling of young trees all contributed to the lack of regeneration that appears responsible for the general decline in overstory vegetation.

48. Culver, David A.; Vaga, Ralph M.; Munch, C. Susan; Harris, Sandra M. 1981. Paleoecology of Hall Lake, Washington: a history of meromixis and disturbance. Ecology. 62(3): 848-863.

The lake has experienced major changes in productivity in the past 350 years due to disturbance in the watershed from lumbering, road construction, and probably periodic use by beaver colonies.

49. Cutright, Warren J.; McKean, Tom. 1979. Countercurrent blood vessel arrangement in beaver (*Castor canadensis*). Journal of Morphology. 161(2): 169-176.

The vascular anatomy of five beavers was studied by dissection and the injection of vinyl acetate into arteries and veins.

50. Dagg, Anne Innis. 1972. Research on Canadian mammals. Canadian Field-Naturalist. 86(3): 217-221.

The author includes Canadian mammal literature from the past 40 years. Journals referenced, dates of publication, authors, region of study, means of funding, and subject matter are presented in tables.

51. Dahm, Clifford N.; Sedell, James R. 1986. The role of beaver on nutrient cycling in streams. Journal of the Colorado-Wyoming Academy of Science. 18(1): 32. Abstract.

Beaver activity affects the cycling of nutrients in streams by increasing the deposit and retention of organic material and by creating zones of anaerobiosis in the sediments.

This increase in overall ecosystem productivity, coupled to the increased and more diverse aquatic habitat, helps make streams with beaver highly productive areas for the rearing of fish.

52. D'Aulaire, Emily; D'Aulaire, Ola. 1973. The beaver is back. National Wildlife. 11(4): 10-13.
The authors cite a few Western United States repopulation programs and discuss the beaver's life history and importance as a much-sought-after furbearer during the mid-1800's.

53. Davies, Robert B.; Hibler, Charles P. 1979. Animal reservoirs and cross-species transmission of *Giardia*. In: Jakubowski, W.; Hoff, J. C., eds. Waterborne transmission of giardiasis: Proceedings of a symposium; 1978 September 18-20; Cincinnati, OH. Cincinnati, OH: U.S. Environmental Protection Agency, Health Effects Research Laboratory: 104-126.
During 1975 to 1977, a survey of people and wild and free-ranging domestic animals for *Giardia* was completed in several areas of Colorado. Fecal samples were examined by a zinc sulfate centrifugation technique. Of 744 samples from 33 species of vertebrates, 44 of 244 beavers (18 percent) were found to be positive for *Giardia*.

54. Davis, Jerry W. 1986. Options for managing livestock in riparian habitats. In: Transactions of the 51st North American wildlife and natural resources conference; 1986 March 21-26; Reno, NV. Washington, DC: Wildlife Management Institute: 290-297.
Caution should be exercised in introducing beavers to enhance riparian habitat. In some cases, beaver can be detrimental to meeting specific objectives.

55. DeByle, Norbert V. 1985. Wildlife. In: DeByle, Norbert V.; Winokur, Robert P., eds. Aspen: ecology and management in the Western United States. Gen. Tech. Rep. RM-119. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 135-152.
Beaver affect aspen stands from cutting and dam building behavior. Sucker regrowth of aspen in flooded areas around beaver dams is not fast enough to sustain beaver populations for long.

56. Deems, Eugene F., Jr.; Pursley, Duane, eds. 1978. North American furbearers: their management, research and harvest status in 1976. College Park, MD: International Association of Fish and Wildlife Agencies; Maryland Department of Natural Resources, Wildlife Administration. 171 p.
This report details the general status of 27 of North America's major terrestrial and semiaquatic furbearers.

57. Denney, Ralph. 1982. Oregon's furbearers. Oregon Wildlife. 37(8): 10-13.
The author reviews the history of Oregon's furbearer management and harvest.

58. Dennington, Malcolm; Johnson, Brian. 1974. Studies of beaver habitat in the Mackenzie Valley and northern Yukon. Report 74-39. Ottawa, ON: Canadian Wildlife Service, Department of the Environment. 172 p.
In determining if there were specific areas or habitat components that would be altered, to the detriment of beaver populations, through construction of a pipeline, the authors concluded that if care was exercised to maintain water regimes, beaver populations on or near the proposed pipeline route should not be adversely affected.

59. Dimock, Edward J., II; Black, Hugh C. 1969. Scope and economic aspects of animal damage in California, Oregon, and Washington. In: Black, H. C., ed. Wildlife and reforestation in the Pacific Northwest. Corvallis, OR: Oregon State University: 10-14.
Included are estimates of timber volumes lost, those animals chiefly responsible, and how land managers assess the damage. Animal damage within California, Oregon, and Washington is probably costing the timber industry several million dollars each year.

60. Dubey, J. P. 1983. *Toxoplasma gondii* infection in rodents and insectivores from Montana. Journal of Wildlife Diseases. 19(2): 149-150.
Rodents and insectivores near Bozeman, MT, were tested for the prevalence of *Toxoplasma gondii*. The disease was isolated in mice inoculated with tissues of one of 27 beavers. The six mice inoculated with pooled tissues of infected beaver developed an antibody titer of >1:256, and *T. gondii* cysts were found in the brains of three of six mice killed.

61. Duncan, Sally L. 1984. Leaving it to beaver. Environment. 26(3): 41-45.
Stresses the role of the beaver "as a regulator rather than a passive inhabitant of streams; an innovator and modifier of riparian vegetation rather than a mere consumer."

62. Dykes, Aubert C.; Juranek, Dennis D.; Lorenz, Rodney A.; Sinclair, Susanne; Jakubowski, Walter; Davies, Robert. 1980. Municipal waterborne giardiasis: an epidemiologic investigation: beavers implicated as a possible reservoir. Annals of Internal Medicine. 92(2, part 1): 165-170.
Beavers were implicated as the most probable source of *Giardia* organisms that produced an epidemic in March 1976 in Camas, WA. Laboratory and epidemiologic evidence is provided, although somewhat incomplete.

63. Emry, Robert J. 1972. A new species of *Agnotocastor* (Rodentia, Castoridae) from the early Oligocene of Wyoming. American Museum Novitates. 2485: 1-7.
A new fossil species of beaver (*Agnotocastor galushai*) was found in early Oligocene deposits of the Flagstaff Rim area, Natrona County, WY.

64. Farrar, Gerald B. 1971. The beaver: the conservationist! Defenders of Wildlife News. 46(2): 205-206.
At Willow Creek, ID, beaver were introduced to a severely eroded stream, resulting in stabilization and lushness surrounding their dam site.

65. Feist, C.; Nice, P. O. 1982. Prevalence of *Giardia* infections among inhabitants of four Alaskan villages. In: Proceedings, 82nd annual meeting of the American Society for Microbiology; 1982 March 12; Atlanta, GA. Washington, DC: American Society for Microbiology: 319. Abstract.
Large beaver populations lead to amplification of contamination of surface waters with *Giardia* cysts.

66. Feldhamer, G. A.; Chapman, J. A. 1984. Other furbearers. In: Mason, Ian L., ed. Evolution of domesticated animals. New York: Longman: 293-297.
Contains information on the distribution, reproduction, and potential for domestication of seven species of furbearers, including the beaver.

67. Ffolliott, Peter F.; Clary, Warren P.; Larson, Frederic R. 1976. Observations of beaver activity in an extreme environment. Southwestern Naturalist. 21(1): 131-133.
Beaver were observed adjacent to small perennial pools formed in normally dry drainages dissecting desert scrub and riparian hardwood vegetation types on Dry Beaver drainage in north-central Arizona. Climatic conditions associated with these pools are often semiarid, which may be considered severe in terms of beaver habitat.

68. Fidler, Vera. 1972. Grey Owl: a man ahead of his time. Canadian Geographic Journal. 84(5): 152-157.
This is a personal history of Grey Owl who, in his later years, resided in Prince Albert National Park, Saskatchewan. Grey Owl was one of the first to carry out an experiment to restore beaver to an area.

69. Finch, Robert. 1984. Silent parables. The Canadian Forum. 64: 40-42.
The history of how the beaver and maple leaf came to be official emblems for Canada.

70. Fisher, Philip H. 1986. Keeping beavers from plugging culvert inlets. Engineering Field Notes. Washington, DC: U.S. Department of Agriculture, Forest Service; 18: 9-13.
The San Dimas Equipment Development Center tested four methods for keeping beavers from plugging culvert inlets: the perforated pipe method, the perforated culvert method, the downspout method, and the baffler method. The downspout approach showed the greatest promise.

71. Fletcher, Colin. 1966. Un-eager beaver. Field and Stream. 71: 53, 100-109.
This life history of beavers includes observations by the author and others who have had contact with them.

72. Foreyt, W. J.; Leathers, C. W. 1984. Mite (*Schizocarpus mingaudi*) infestations of ranch-raised beavers. Journal of the American Veterinary Medical Association. 185(11): 1414-1415.
In April and May 1981, at a commercial ranch near Kimberly, ID, approximately 50 beavers of all ages and both sexes died. Investigators found numerous adult mites attached to hair shafts on the preserved skin. Treatment of nest boxes was carried out using 50 percent wettable diazinon powder.

73. Francis, Margaret M.; Naiman, Robert J.; Melillo, Jerry M. 1985. Nitrogen fixation in subarctic streams influenced by beaver (*Castor canadensis*). Hydrobiologia. 121(3): 193-202.
The authors measured nitrogen fixation in four subarctic streams substantially modified by beaver in Quebec, Canada. The authors estimated that total nitrogen accumulation in sediment, per unit area, is enhanced nine to 44 times by beaver damming a section of stream.

74. Frost, Floyd; Plan, Byron; Liechty, Bill. 1980. *Giardia* prevalence in commercially trapped mammals. Journal of Environmental Health. 42(5): 245-249.
A *Giardia* outbreak in Camas, WA, prompted the Washington State Health Services Division to survey wild beaver and muskrat for prevalence of *Giardia* infection to determine if animal contamination of other water supplies could occur. Surveys were conducted in 1976-77, 1977-78, and 1978-79. Annual percentages of beaver contaminated were 6.3, 6.8, and 19, respectively.

75. Fuller, Todd K.; Keith, Lloyd B. 1980. Wolf population dynamics and prey relationships in northeastern Alberta. Journal of Wildlife Management. 44(3): 583-602.
Wolf population studies from October 1975 through June 1978 on two study areas in northern Alberta showed that beaver populations were directly related to beaver occurrence in wolf scat. Consumption of beaver varied greatly between packs.

76. Gainer, Robert; Smith, Kirby. 1985. Mineralization of subcutaneous tissue in beaver, *Castor canadensis*. The Canadian Field-Naturalist. 99(4): 535-536.
The subcutaneous surface of the hides of two yearling kits, shot by a local trapper in the central Alberta foothills, had a white, 0.5 to 2 mm thick, meshlike layer of a stiff and fibrous material that covered most of the anterior dorsal portion of the hides.

77. Gerhart, Bill. 1979. The land along the water: riparian zones are critical for wildlife survival. Wyoming Wildlife. 43(11): 20-23.
The beaver is one of many mammals dependent on riparian habitat for all or part of their life cycle.

78. Gill, Don. 1972. The evolution of a discrete beaver habitat in the Mackenzie River Delta, Northwest Territories. The Canadian Field-Naturalist. 86(3): 233-239.
This study traced through time the sequence of physical and biological events that create a discrete beaver habitat, conducive to the colonization of a poplar (*Populus balsamifera*) seral community.

79. Gill, Don. 1978. Some ecological and human consequences of hydroelectric projects in the Mackenzie

River drainage system, northwestern Canada. Occas. Publ. 14. Edmonton, AB: Boreal Institute for Northern Studies, University of Alberta: 73-82.
This paper called attention to the ecological alteration that can and has already occurred below large hydroelectric projects on northern rivers. Northern floodplains and deltas are most subject to downstream regulation-caused damage. Beaver use floodplains and deltas as their primary habitat. If flooding and siltation were to no longer take place, the riparian community would be replaced by a white spruce (*Picea glauca*) climax forest, virtually unusable by beaver.

80. Gordon, Kenneth. 1966. Mammals and the influence of the Columbia River Gorge on their distribution. Northwest Science. 40(4): 142-146.
This paper deals with the Columbia River to the confluence of the Snake River and the latter stream to the point where it flows around the north end of the Blue Mountains, and considers these streams as they were before dams were built. The Columbia River is a barrier for many mammals, and the gorge lets many mammals breach the Cascade Mountain barrier that cannot go over an unbroken range. Beaver are one of 14 members found in the Columbia River vicinity that have transgressed the stream.

81. Grover, Jerry. 1984. Don't drink the water. Oregon Wildlife. 39(7): 10-11.
Beaver are involved in the transmission of *Giardia* spp. Their aquatic habits ensure a steady supply of the parasite to the water. *Giardia lamblia* is probably the most common intestinal parasite in the United States.

82. Guenther, Keith; Kucera, Thomas E. 1978. Wildlife of the Pacific Northwest: occurrence and distribution by habitat, B.L.M. District and National Forest. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 128 p.
The authors review the relationship of regularly occurring vertebrates to plant communities and their successional stages, and dependency upon and use of aquatic and special and unique habitats. They include a checklist with relative abundance, residence status, and classification by State for all vertebrates found in Oregon and Washington.

83. Hall, H. A.; Pritchard, G. 1975. The food of larvae of *Tipula sacra* Alexander in a series of abandoned beaver ponds (Diptera: Tipulidae). Journal of Animal Ecology. 44(1): 55-66.
Larvae of the cranefly living in abandoned beaver ponds in the Kananaskis Forest Reserve, AB, ingest diatoms, filamentous algae, mineral particles, and detritus from the benthic sediments.

84. Hartman, Alan M. 1975. Analysis of conditions leading to the regulation of water flow by a beaver. The Psychological Record. 25: 427-431.
A young beaver was selected for observation and experimentation and for evaluating the bases of water-regulation behavior. Rates and timing of activities were examined against variation in water flow, temperature, level, time of day, and ambient as well as water-specific sounds.

85. Hawkes, Fredrick W. 1973. Elk, moose, and beaver. Pacific Discovery. 26(3): 12-15.
Hawkes describes the "valuable ecological consequences" that beaver have on elk and moose habitat by their swamp-building ability and resultant growth of food-producing shrubs and small trees.

86. Hawley, Vernon D. 1971. Furbearers of the Mackenzie Delta. 1971 Report. Ottawa, ON: Canadian Wildlife Service: 51-52.
Hawley summarizes part of Michael Aleksiuk's 1968 thesis on how the energy regime of northern beavers fluctuates. Information also includes the composition, distribution, and density of beaver populations in the study area.

87. Herb, Gene. 1986. Urban wildlife habitat – can it be maintained? Oregon Wildlife. 41(2): 4-7.
Herb discusses the importance of wetlands as wildlife habitat and the need to protect them. Large numbers of wildlife use the areas because of the abundance of water, food, cover, and nesting areas. Beaver depend upon wetlands for survival.

88. Hill, Edward P. 1982. Beaver. In: Chapman, Joseph A.; Feldhamer, George A., eds. Wild mammals of North America: biology, management, and economics. Baltimore, MD: Johns Hopkins University Press: 256-281.
The author discusses the distribution, physiology, reproduction, ecology, behavior, mortality, economic status, and management of beaver throughout its present range in North America.

89. Hill, E. P.; Novakowski, N. S. 1984. Beaver management and economics in North America. Acta Zoologica Fennica. 172: 259-262.
The authors discuss management (season, traps, damage) and economics (markets, supply and demand, prices, harvest trends) of beaver in North America.

90. Hodgdon, H. E.; Lancia, R. A. 1983. Behavior of the North American beaver, *Castor canadensis*. Acta Zoologica Fennica. 174: 99-103.
The authors attempt to synthesize data on North American beaver into a general scheme. Discussion is limited to intensive studies of individually marked animals of known sex and age class.

91. Hodgdon, Harry E.; Larson, Joseph S. 1980. A bibliography of the recent literature on beaver. Res. Bull. 665. Amherst, MA: University of Massachusetts, Agricultural Experiment Station. 128 p.
The authors have supplemented and updated earlier bibliographies on beaver.

92. Hodkinson, I. D. 1975. A community analysis of the benthic insect fauna of an abandoned beaver pond. Journal of Animal Ecology. 44(2): 533-551.

Subjects of the study were the feeding biology, distribution relative to substrate type, and adult phenology of benthic insects associated with a shallow, abandoned beaver pond in Kananaskis Valley, AB, Canada. The insect fauna of beaver ponds differ markedly from streams, rivers, and lakes. Larvae of Diptera, especially Tipulidae, are the major faunal components.

93. Hodkinson, I. D. 1975. Dry weight loss and chemical changes in vascular plant litter of terrestrial origin, occurring in a beaver pond ecosystem. Journal of Ecology. 63(1): 131-142.
This study, part of a larger project, assessed the role of allochthonous detritus in an abandoned beaver pond ecosystem in the Kananaskis Valley, AB, Canada. All five litter types (***Salix*** sp., ***Pinus contorta, Juncus tracyi, Deschampsia cespitosa, Picea glauca***) differed significantly in their rate of breakdown over the 18-month study.

94. Hodkinson, I. D. 1975. Energy flow and organic matter decomposition in an abandoned beaver pond ecosystem. Oecologia. 21(2): 131-139.
During 1973 inflow and outflow of energy were measured independently for one spring-fed pond in the Kananaskis Valley, AB, Canada. Of the total yearly energy inflow, 18 percent was exported, 26 percent was respired, and 56 percent accumulated in the sediments. The author concluded that the beaver pond is a highly accretive heterotrophic ecosystem.

95. Hoover, W. H.; Clarke, S. D. 1972. Fiber digestion in the beaver. Journal of Nutrition. 102(1): 9-15.
Levels of dry matter, acid detergent fiber, lignin, protein, and volatile fatty acids were determined in the ingesta at several locations in the gastrointestinal tract. Average cellulose digestion was estimated at 30 percent and protein at 44 percent. Total volatile fatty acids were highest in the cecum and upper colon.

96. Horstman, Louise P. 1979. Evaluation of beaver depredation and control in the Edmonton Fish and Wildlife Region, 1979. Edmonton, AB: Alberta Energy and Natural Resources, Fish and Wildlife Division. 36 p.
This study evaluated the characteristics and economic loss resulting from beaver depredation and the cost and effectiveness of beaver control programs.

97. Howard, Rebecca J.; Larson, Joseph S. 1985. A stream habitat classification system for beaver. Journal of Wildlife Management. 49(1): 19-25.
Documentation over 28 years of beaver (*Castor canadensis*) habitat use on the Prescott Peninsula, New Salem, MA, permitted development and testing of two models to predict maximum density of active beaver colonies on streams. In mixed coniferous-deciduous forest habitat, the percentage of hardwood vegetation, watershed size, and stream width had significant positive effects on active colony density. Increasing stream gradient and progressively well-drained soils had negative effects. The models were 80 and 75 percent reliable in predicting active colony density.

98. Hudson, J. E. 1978. Canada's national mosquito? Mass-resting of ***Anopheles earli*** (Diptera: Culicidae) females in a beaver lodge in Alberta. Canadian Entomologist. 110(12): 1345-1346.
In May 1976, researchers collected 1,362 mosquitos (***Anopheles earli***) from a beaver lodge near George Lake, AB; 39.2 percent were blood-fed and 3.1 percent were gravid.

99. International Wildlife. 1983. Behind the scenes; the American beaver. International Wildlife. 13: 24D.
Beavers may be more important to aquatic ecology and to the formation of prairies and wetlands than biologists had realized. When the animals dam streams they begin a process that causes ponds to spread and later evolve into watery meadows.

100. Jeffress, Jim. 1975. The beaver (*Castor canadensis*). Nevada Outdoors and Wildlife Review. 9(4): 1-6.
Beavers were planted in many parts of Nevada primarily as a means of creating upstream water storage and improving the fisheries resources, rather than for the monetary value of the furs.

101. Jenkins, Stephen H. 1979. Seasonal and year-to-year differences in food selection by beavers. Oecologia. 44: 112-116.
From September 1972 through April 1974 beavers exhibited seasonal and year-to-year differences in preference for certain genera of trees in central Massachusetts.

102. Jenkins, Stephen H. 1980. A size-distance relation in food selection by beavers. Ecology. 61(4): 740-746.
Jenkins found that for most tree genera, beaver cut a smaller range of sizes far from shore than close to shore and more smaller trees and fewer large trees at greater distances. His study was conducted in a deciduous forest of central Massachusetts.

103. Jenkins, Stephen H. 1981. Problems, progress, and prospects in studies of food selection by beavers. In: Chapman, J. A.; Pursley, D., eds. Proceedings, worldwide furbearer conference; 1980 August 8-11; Frostburg, MD. Frostburg, MD: Worldwide Furbearer Conference, Inc.: 559-579.
Beavers exhibit strong selection for particular types of plants under certain circumstances. If herbaceous vegetation is available, beavers appear to prefer it to woody vegetation during all seasons.

104. Jenkins, Stephen H.; Busher, Peter E. 1979. *Castor canadensis*. Mammalian Species 120. Provo, UT: American Society of Mammalogists. 8 p.
The authors summarize information on the life history and ecology of the North American beaver.

105. Johannsen, Neil. 1970. About beavers. Pacific Search. 5(3): 8.
Johnannsen has written a brief life history of the North American beaver.

106. John, Rodney T. 1971. Utah furbearers: harvest report and management recommendations 1970-1971. Publ. 71-8. Salt Lake City, UT: Utah Department of Natural Resources, Division of Wildlife Resources. 15 p.
The author summarizes beaver harvest by counties, fur sales, harvest summary, statewide trend of harvest, population status, and nuisance complaints.

107. Johnson, Donald R.; Chance, David H. 1974. Presettlement overharvest of upper Columbia River beaver populations. Canadian Journal of Zoology. 52(12): 1519-1521.
This study looked at beaver population fluctuations between 1835 and 1850 as shown in fur harvest reports.

108. Johnson, Johnny. 1981. Leave it to beaver. Natural History. 90: 44-47.
The author looks at the techniques that beavers use in coping with the dangers and difficulties of winter in Alaska's Mt. McKinley National Park.

109. Johnson, Phillip. 1984. The dam builder is at it again! National Wildlife. 22(4): 8-15.
Johnson reviews some of the current studies done on eroded trout streams in Montana and Wyoming using beaver for habitat recovery.

110. Journal of the Arizona Academy of Sciences. 1974. Late Pleistocene fossils from Glendale, Clark County, Nevada. Journal of the Arizona Academy of Sciences. 9(Suppl.): 34.
Vertebrate samples were collected in 1937-38 by the National Park Service. *Castor* kit fossils suggest they may have been deposited in the backwater of a beaver dam.

111. Karsten, Peter. 1983. Displaying natural rearing of beaver (*Castor canadensis*). Zoologische Garten. 53(6): 404-408.
A look-in lodge display was built for beaver at the Calgary Zoo. In 1978 the first reproduction and successful raising of young occurred.

112. Kebbe, Chester E. 1969. Fashions and furs. Oregon State Game Commission Bulletin. 24(11): 3, 5-6.
Changing trends in the world of fashion strongly influence the cropping of fur animals. Therefore, in fur-bearer management, two main variables must be considered: the population status and demand for the fur of each species.

113. Kebbe, Chet E. 1975. Fur trapping – a half million dollar business. Oregon Wildlife. 30(10): 10-11.
Oregon's fur trapping industry shows signs of continuing for many years. This article discusses the 1974-75 fur take by trappers.

114. Kelsall, John P.; Telfer, E. S.; Wright, Thomas D. 1977. The effects of fire on the ecology of the boreal forest with particular reference to the Canadian north: a review and selected bibliography. Occas. Pap. 32. Ottawa, ON: Canadian Wildlife Service. 58 p.
The authors concluded that fire is the most important factor influencing the ecology of the northern boreal forest. The beaver is best adapted to early stages of forest succession because it depends primarily on deciduous trees for food and building supplies.

115. Kindschy, R. R. 1985. Response of red willow to beaver use in southeastern Oregon. Journal of Wildlife Management. 49(1): 26-28.
Kindschy documents the effect of beaver use on red willow (*Salix lasiandra*) in an area unused by domestic livestock.

116. Klebenow, Donald A.; Oakleaf, Robert J. 1984. Historical avifaunal changes in the riparian zone of the Truckee River, Nevada. In: Warner, Richard E.; Hendrix, Kathleen M., eds. California riparian systems: ecology, conservation, and productive management. Berkeley, CA: University of California Press: 203-209.
Beaver harvest of mature trees, along with overgrazing by cattle, has contributed to some of the historical avifaunal changes that have been observed since 1868.

117. LaBastille, Anne. 1979. The best dam builder around. National Wildlife. 17(3): 26-33.
The author briefly reviews beaver life history, nuisance complaints, and management.

118. Lang, Bruce Z. 1977. Snail and mammalian hosts for *Fasciola hepatica* in eastern Washington. Journal of Parasitology. 63(5): 938-939.
Various mammalian hosts were infected with *Fasciola hepatica*, beaver among them. Of 53 hosts checked from 1968 through 1975, three of 12 beaver had mature worms in the hepatic and common bile ducts. Ten mature flukes were recovered from infected beaver.

119. Langford, E. V. 1972. *Pasteurella pseudotuberculosis* infections in Western Canada. Canadian Veterinary Journal. 13(4): 85-87.
Langford reported 20 incidents of infection with *Pasteurella pseudotuberculosis* over a 14-year period in western Alberta and British Columbia. One beaver was infected with the organism.

120. Larson, J. S.; Gunson, J. R. 1983. Status of the beaver in North America. Acta Zoologica Fennica. 174: 91-93.
Mail surveys of biologists in North America and reports and contacts with Canadian biologists provided the information for this report. Figures and tables present beaver harvest trends for the United States and selected areas of Canada.

121. Leege, Thomas A. 1968. Beavers on the move. Idaho Wildlife Review. 20(5): 14-16.
Beaver were live trapped and tagged from National Forest lands adjacent to problem areas of southeastern Idaho during the summers of 1962 and 1963. Movements were then recorded for those tagged animals that were retrapped.

122. Leege, Thomas A. 1968. Natural movements of beavers in southeastern Idaho. Journal of Wildlife Management. 32(4): 973-976.

Data from 192 live trapped and tagged beaver helped determine the origin of troublesome beaver on private lands. The yearling age class and males of all groups migrate the most frequently.

123. Leege, Thomas A.; Williams, Roger M. 1967. Beaver productivity in Idaho. Journal of Wildlife Management. 31(2): 326-332.

The authors gathered data on sex and age ratios, litter size, and rate of pregnancy from live-trapping and fur-trapping operations in 1953-56 and 1962-64. Males consistently outnumbered females in kit and yearling age classes, while females were more abundant among the adults. The sex ratio of 352 beavers examined was 113 males per 100 females. A disturbed population had a lower percentage of kit and yearling beavers than did an undisturbed population.

124. Lindsey, E. H. 1972. Small mammal fossils from the Barstow Formation, California. University of California Publications in Geological Sciences. 93: 34-35.

Describes the fossil remains of the family Castoridae collected from the Barstow formation.

125. Lulman, P. D. 1974. Moose and muskeg, birch and beaver, natural environment and wildlife. Occas. Publ. 12. Edmonton, AB: University of Alberta, Boreal Institute for Northern Studies: 23-32.

Lulman described what early explorers and trappers might have seen on a journey of the Athabasca River before human pressures changed the face of the land through fire, clearing, and mining.

126. Mace, Robert U. 1970. Oregon's furbearing animals. Wild. Bull. 6. Portland, OR: Oregon State Game Commission. 82 p.

The author summarizes descriptions and distributions of the various furbearing mammals found in Oregon.

127. Martin, Pete. 1977. Furbearers on the Yellowstone. Montana Outdoors. 8(2): 36-38.

Major flow reductions of the Yellowstone Basin could encourage beaver to build more dams, thus triggering the following: reduced food supply because of extensive additional cuttings of cottonwood and willow; banks with weakened resistance to erosion during peak flows; and habitat loss for other wildlife species that use cottonwoods and willows for nesting, perching, and protective cover.

128. Martin, Peter R. 1977. The effect of altered streamflow on furbearing mammals of the Yellowstone River Basin, Montana. Tech. Rep. 6. Helena, MT: Water Resources Division, Montana Department of Natural Resources and Conservation. 79 p.

Martin discusses the potential physical, biological, and water use impacts of water withdrawals and water development on the middle and lower reaches of the Yellowstone River Basin on migratory birds, furbearers, recreation, and existing water users. Increased winter flows could wash away food caches, forcing beaver to constantly expose themselves to the elements and predators. Low flows in early fall would stimulate dam building, thus decreasing available food supply, weakening bank resistance to erosion, and reducing habitat for other wildlife species.

129. Mayse, Charley. 1980. A beaver trapper's tale. Alaska. 46: A2-A5; A28-A31.

The author shares his actions, problems, and thoughts as he goes about, alone, trapping beaver in the wilderness of Alaska.

130. McDowell, Robert A. 1975. A study of the Pole Mountain fishery: beaver pond, artificial impoundment and stream investigations. Completion Report, Dingle-Johnson Project F-44-R-01. Laramie, WY: Fish Division of the Wyoming Game and Fish Department. 174 p.

The waters of concern in the Pole Mountain area are almost entirely composed of beaver ponds that are not static and therefore are subject to change. Consequently, the fishery is in constant flux. McDowell concluded that high beaver population densities result in short-term, unstable pond conditions due to rapid habitat losses. Balanced management for beaver in relation to available food supply will provide continued aquatic habitat for trout.

131. McGinley, Mark A.; Whitham, Thomas G. 1985. Central place foraging by beavers (*Castor canadensis*): a test of foraging predictions and the impact of selective feeding on the growth form of cottonwoods (*Populus fremontii*). Oecologia. 66(4): 558-562.

In testing theories of central place foraging among beaver along the San Juan River in southern Utah, the authors found that large branches were favored at all distances. This differed from patterns observed in previous studies.

132. McIntre, Rick. 1981. Death of a beaver pond. Alaska. 47: 50.

Grizzlies and wolves succeeded in killing or forcing a beaver colony to abandon its lodge in Denali National Park. This eventually led to the death of the pond and its replacement by a huge mud flat and meandering stream.

133. McKean, Tom. 1982. Cardiovascular adjustments to laboratory diving in beavers and nutria. American Journal of Physiology. 242(2): R434-R440.

Beavers were anesthetized and prepared for monitoring (by immersion in 15-20 °C water for 4 minutes) of regional distribution of blood flow; cardiac output, oxygen consumption, arterial and venous blood gases, and pH. Rate of decline of oxygen stores during diving decreased by 93 percent, regional blood flow decreased to all organs except the adrenals, heart, and lungs, and blood flow to the brain increased during dives.

134. McKean, Tom; Carlton, Candy. 1977. Oxygen storage in beavers. Journal of Applied Physiology. 42(4): 545-547.

Ten wild beavers were live trapped and taken to the laboratory at the University of Idaho, Moscow. They were anesthetized with pentobarbital, and then the researchers determined total lung capacity, hemoglobin, blood volume, and myoglobin. These measured values were used to calculate total oxygen storage capacity.

135. McKelvey, Richard W.; Dennington, Malcolm C.; Mossop, David. 1983. The status and distribution of trumpeter swans (*Cygnus buccinator*) in the Yukon. Arctic. 36(1): 76-81.
The presence of a breeding population of trumpeter swans was established from previous summer records of swans and by data from extensive aerial surveys. Beaver activity is an important influence in the development of ponds used by swans.

136. McKern, John L. 1978. Inventory of riparian habitats and associated wildlife along the Columbia and Snake rivers. Summary Rep. 1. Walla Walla, WA: U.S. Army Corps of Engineers, North Pacific Division. 100 p.
The Wildlife Working Group (composed of various fish and game personnel from Oregon, Washington, and Idaho) assessed the impact of controlled water level fluctuations on riparian and associated upland habitat, vertebrate species using these habitats, and proposed river regulation impacts upon these habitats.

137. Michelmore, Peter. 1984. The amazing beavers of Currant Creek. Reader's Digest. 124(4): 109-113.
Beavers were used to help restore severely eroded trout streams of southwestern Wyoming.

138. Miller, James E. 1983. Beavers. In: Timm, Robert M., ed. Prevention and control of wildlife damage. Lincoln, NB: Institute of Agriculture and Natural Resources, University of Nebraska: B1-B11.
The author focuses primarily on damage prevention and control methods, such as repellents, traps, and shooting.

139. Miller, L. Keith. 1967. Microclimate of northern beaver: a constructed habitat. In: Fourth international biometerological congress; 1966 August 26-September 2; New Brunswick, NJ. New Brunswick, NJ: Rutgers University: 288.
Temperatures measured in the walls and living chambers of four beaver lodges near Fairbanks, AK, over 1 year, showed that body heat was a significant factor in maintaining inner lodge temperatures.

140. Miller, L. Keith. 1967. Caudal nerve function as related to temperature in some Alaskan mammals. Comparative Biochemistry and Physiology. 21(3): 679-686.
This study compared peripheral nerve function at low temperature in a variety of mammals, including beaver, from interior Alaska.

141. Miller, L. Keith. 1970. Temperature-dependent characteristics of peripheral nerves exposed to different thermal conditions in the same animal. Canadian Journal of Zoology. 48(1): 75-81.
In beavers from the vicinity of Fairbanks, AK, nerves accustomed to tissue temperatures approaching 0 °C were compared with nerves that encounter less severe cooling and nerves that are accustomed only to deep body temperature. Conduction velocity-temperature slopes of the three nerves were different, and absolute refractory periods in the cold-adapted nerves were significantly shorter at low temperatures.

142. Molini, John J.; Lancia, Richard A.; Bishir, John; Hodgdon, Harry E. 1980. A stochastic model of beaver population growth. In: Chapman, J. A.; Pursley, D., eds. Proceedings, worldwide furbearer conference; 1980 August 8-11; Frostburg, MD. Frostburg, MD: Worldwide Furbearer Conference, Inc.: 1215-1245.
The researchers developed a mathematical model of the growth phase of an unexploited beaver (*Castor canadensis*) population in Massachusetts. The rate of pair formation between dispersed individuals varied as a function of the number of occupied colony sites within an area containing a fixed number of suitable sites.

143. Moore, Tommy D.; Spence, Liter E.; Dugnolle, Charles E. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Cheyenne, WY: Wyoming Game and Fish Department. 186 p.
This is intended as an aid in ecological and food habit studies and in law enforcement investigations.

144. Muchmore, Duane. 1975. Beaver, if you will. Wyoming Wildlife. 39(1): 16-21, 34.
Muchmore reviews beaver life history, trapping, reintroduction, management, and habitat preference in Wyoming.

145. Munther, Greg L. 1982. Beaver management in grazed riparian ecosystems. In: Peek, J. M.; Dalke, P. D., eds. Wildlife-livestock relationships symposium: proceedings 10; 1981 April 20-22; Coeur d'Alene, ID. Moscow, ID: University of Idaho: 234-241.
Stream reach evaluations were conducted on 20 livestock allotments within the Deerlodge and Lolo National Forests of Montana to assess compatibility of cattle with riparian resources.

146. Munther, Greg L. 1983. Integration of beaver into forest management. In: Proceedings, annual meeting Colorado-Wyoming Chapter American Fisheries Society; 1983 March 2-3; Laramie, WY. [Publisher and city unknown]: 73-80.
Munther discusses the impacts of beaver on wildlife, water quality and quantity, fish habitat and populations, recreation, livestock, forest vegetation, and condition of transportation facilities.

147. Naiman, Robert J.; Melillo, Jerry M. 1984. Nitrogen budget of a subarctic stream altered by beaver (*Castor canadensis*). Oecologia. 62(2): 150-155.
The authors constructed a nitrogen budget for a section of a second order stream in eastern Quebec and a beaver dam in that stream. The beaver-modified section accumulated approximately 1,000 times more nitrogen than before

alteration. The ecosystem implications of beaver activity suggest that current concepts of patterns and processes in running waters require modification.

148. Naiman, Robert J.; Melillo, Jerry M.; Hobbie, John E. 1986. Ecosystem alteration of boreal forest streams by beaver *(Castor canadensis)*. Ecology. 67(5): 1254-1269.

Effects of beaver activity were considered on several major ecosystem components and processes in boreal forest drainage networks in Quebec, Canada. Results suggest that current concepts of the organization and diversity of unaltered stream ecosystems in North America should recognize the keystone role of beaver because drainage networks with beaver are substantially different in their biogeochemical economies from those without beaver.

149. Navin, Thomas R.; Juranek, Dennis D.; Ford, Michael; Minedew, David J.; Lippy, Edwin D.; Pollard, Robert A. 1985. Case-control study of waterborne giardiasis in Reno, Nevada. American Journal of Epidemiology. 122(2): 269-275.

An outbreak of *Giardia lamblia* gastroenteritis occurred in Reno, NV, in 1982. *Giardia* cysts were recovered from the water supply and a beaver infected with *Giardia* was found in one of the reservoirs. Corrective measures included the removal of the infected beaver.

150. Nelson, Lewis, Jr.; Hooper, J. K. 1976. California furbearers and their management. Leaflet 2721. Berkeley, CA: University of California Cooperative. 22 p.

The authors discuss the value, history, management, and future of California's furbearers.

151. Novakowski, N. S. 1967. The winter bioenergetics of a beaver population in northern latitudes. Canadian Journal of Zoology. 45(6, part 1): 1107-1118.

In a study in Wood Buffalo National Park of Alberta and the Northwest Territories, Novakowski found that energy deficits are a product of the winter behavior of the animals and that energy conservation and an increase in fur insulation and fat deposition provide the necessary mechanisms for survival.

152. Novakowski, N. S. 1969. The influence of vocalization on the behaviour of beaver, *Castor canadensis*. American Midland Naturalist. 81(1): 198-204.

This is an analysis of a group of sounds made by 14 beaver kept in confinement on the University of Saskatchewan campus. The study related sound production to age in beaver and also to behavior and survival. Because beavers are an herbivore and a prey species, vocalization while foraging would seem to have no survival value. Vocalization primarily occurs within the lodge.

153. Novakowski, N. S.; Solman, V. E. F. 1975. Potential of wildlife as a protein source. Journal of Animal Science. 40(5): 1016-1019.

This study examined the present potential of wildlife as a protein source. Beaver have been a source of protein for many years.

154. Oertli, Erwin F. 1976. The beavers of Kananaskis Forest. Nature Canada. 5(1): 3-8.

Oertli describes his various methods of observation along with the behavioral patterns of beaver in the Rocky Mountains of Alberta, Canada.

155. Olterman, James H.; Verts, B. J. 1972. Collections containing mammals from Oregon. Special Report 362. Salem, OR: Oregon Agricultural Experiment Station. 28 p.

This current record of collections containing beaver and other mammals from Oregon lists the numbers of each species on deposit in each collection.

156. Oregon Department of Fish and Wildlife. 1977. Furtaking continues as a mini-industry. Oregon Wildlife. 32(11): 10.

Furtaking is Oregon's oldest industry. Furs taken in 1977 brought nearly $1.2 million to approximately 1,500 licensed furtakers.

157. Owen, Carlton N.; Adams, Danny L.; Wigley, T. Bently. 1984. Inefficacy of a deer repellent on beavers. The Wildlife Society Bulletin. 12(4): 405-408.

This study, conducted in the bottomland and mixed pine-hardwood forests of Bradley, Clark, Cleveland, and Dallas Counties, AR, evaluated the effectiveness of Magic Circle as a potential beaver repellent. Contrary to previous reports, Magic Circle did not discourage beavers from repairing dams.

158. Parker, Michael. 1986. Beaver, water quality, and riparian systems. In: Proceedings, Wyoming water 1986 and streamside zone conference; 1986 April 28-30; Casper, WY. Laramie, WY: University of Wyoming, Agricultural Extension Service: 88-94.

A complex of beaver dams can improve the quality of water flowing through them, according to studies on a section of Currant Creek in southwestern Wyoming during May-August 1984 and April-June 1985.

159. Parker, Michael; Wood, Fred J., Jr.; Smith, Bruce H.; Elder, Robert G. 1985. Erosional downcutting in lower order riparian ecosystems: have historical changes been caused by removal of beaver? In: Johnson, R. Roy; Ziebell, Charles D.; Patton, David R.; Ffolliott, Peter F.; Hamre, R. H., tech. coords. Riparian ecosystems and their management: reconciling conflicting uses; first North American riparian conference; 1985 April 16-18; Tuscon, AZ. Gen. Tech. Rep. RM-120. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 35-38.

A simple model is proposed to measure the potential of beaver to resist perturbations of lower order streams.

160. Payne, N. F. 1984. Population dynamics of beaver in North America. Acta Zoologica Fennica. 172: 263-266.

Payne looked at density, colony size, reproduction, and mortality of beaver populations in North America.

161. Payne, Neil F.; Munger, Garet P.; Matthews, John W.; Taber, Richard D. 1976. Inventory of vegetation and wildlife in riparian and other habitats along the upper Columbia River. Walla Walla, WA: U.S. Army Corps of Engineers, North Pacific Division. 560 p.
This study aims: to identify, delineate, and describe the riparian and associated upland habitats; to identify wild vertebrates, excluding fish, using these habitats; to establish indices and population estimates where possible; and to make preliminary assessments of river regulation impacts upon these habitats and their associated populations.

162. Peterson, Steven R.; Low, Jessop B. 1977. Waterfowl use of Uinta Mountain wetlands in Utah. Journal of Wildlife Management. 41(1): 112-117.
Adult waterfowl preferred beaver ponds larger than 0.4 ha over natural catchment basins of the same size.

163. Pritchard, G. 1976. Growth and development of larvae and adults of *Tipula sacra* Alexander (Insecta: Diptera) in a series of abandoned beaver ponds. Canadian Journal of Zoology. 54(2): 266-284.
Conducted in the Kananaskis Valley of Alberta, this study examined the role of crane flies in energy and nutrient turnover and tested certain ideas concerning life history strategies in aquatic insects.

164. Pritchard, G.; Hall, H. A. 1971. An introduction to the biology of craneflies in a series of abandoned beaver ponds, with an account of the life cycle of *Tipula sacra* Alexander (Diptera; Tipulidae). Canadian Journal of Zoology. 49(4): 467-482.
The authors describe five beaver ponds that were abandoned for about 10 years in an area of white spruce-lodgepole pine forest in the Kananaskis Forest Reserve in the eastern foothills of the Rocky Mountains in Alberta. They also describe the life cycle of the cranefly. Craneflies are clearly important in terms of energy flow, and there are some interesting relationships between their distribution and abundance and habitat conditions.

165. Pritchard, G.; Leischner, T. G. 1973. The life history and feeding habits of *Sialis cornuta* Ross in a series of abandoned beaver ponds (Insecta; Megaloptera). Canadian Journal of Zoology. 51(2): 121-131.
Alderflies were studied in abandoned beaver ponds in the Kananaskis Forest Reserve of Alberta.

166. Rabe, Fred W. 1970. Brook trout populations in Colorado beaver ponds. Hydrobiologia. 35(3/4): 431-448.
Habitat inventory and evaluation of brook trout populations from 57 beaver ponds in Colorado permitted comparisons of stunted and nonstunted populations of fish and the environmental conditions under which the populations occurred.

167. Ray, Arthur J. 1975. Some conservation schemes of the Hudson's Bay Company, 1821-50: an examination of the problems of resource management in the fur trade. Journal of Historical Geography. 1(1): 49-68.
Hudson's Bay Company tried to introduce beaver conservation schemes in western Canada between 1821 and 1850. This study looks at the lands that lie within the company's northern department.

168. Rea, Amadeo M. 1983. Once a river: bird life and habitat changes on the Middle Gila. Tucson, AZ: University of Arizona Press. 285 p.
Overtrapping of beaver and subsequent loss of their dams is one of the multiple causes for watershed deterioration of the Gila River and its tributaries in New Mexico.

169. Reilly, Phil. 1978. Review of progress in development and testing of humane animal traps. Canadian Wildlife Service, Progress Notes. 86: 1-5.
The Canadian Wildlife Service was involved in the development and testing of traps. Results showed that a trap, if it is to kill humanely, should be designed to avoid impacts in the abdominal region.

170. Robinson, David. 1978. Beaver builders: sturdy dams shaped our land and history. Defenders. 54(3): 153-160.
Beavers have the power to change both the history and the topography of the land by their way of life.

171. Rowe, J. S,; Scotter, G. W. 1973. Fire in the boreal forest. Quaternary Research. 3(3): 444-464.
Fires in some parts of the boreal forest have proven to be beneficial to beaver populations by replacing the coniferous forest with aspen and willow.

172. Science '83. 1983. Beavers: a dam site better on erosion. Science '83. 4(9): 7.
For 6 years beavers helped the U.S. Department of the Interior, Bureau of Land Management to combat soil erosion in southwestern Wyoming. Projects are now under way to help curb erosion near Salt Lake City, UT.

173. Science Digest. 1984. New faith in beaver ecology. Science Digest. 92(7): 36.
The introduction of beaver by the U.S. Department of the Interior, Bureau of Land Management on Wyoming's Currant Creek to help control erosion has succeeded in slowing stream flow and reducing sediment transport. Rye grass and willow have returned to the banks and spring flooding has been regulated.

174. Scott, Lauren B. 1984. Economic values of three furbearers inhabiting California riparian systems. In: Warner, Richard E.; Hendrix, Kathleen M., eds. California riparian systems: ecology, conservation, and productive management. Berkeley, CA: University of California Press: 731-738.
The author makes an effort to establish some basic information on the economic value of sustained harvest of California's beaver, mink, and muskrat.

175. Sedell, James R.; Swanson, Frederick J.; Gregory, Stanley V. 1985. Evaluating fish response to woody debris. In: Hassler, Thomas J., ed. Pacific Northwest stream habitat management workshop; 1984 October 10-12; Arcata, CA. Arcata, CA: Humboldt State University: 222-245.
The authors evaluated the role of coarse woody debris in the geomorphology of streams, specifically: longitudinal profiles, channel patterns and positions, channel geometry, sediment and organic matter storage, and channel dynamics. They also examined the fisheries implications of coarse woody debris, including blockage to migration, water quality, and summer and winter rearing habitat.

176. Shay, Ron. 1978. Oregon's beaver. Oregon Wildlife. 33(2): 3-5.
Shay relates the history of beaver trapping in Oregon.

177. Silovsky, Gene D.; Pinto, Carlos. 1974. Forest wildlife inventories: identification of conflicts and management needs. In: Black, H. C., ed. Wildlife and forest management in the Pacific Northwest. Corvallis, OR: Oregon State University, School of Forestry: 53-61.
Wildlife and their preferred habitats were inventoried on the Suislaw National Forest of the Oregon coast in 1973 and 1974 to determine general changes in wildlife habitats resulting from timber management. Timber management activities were not expected to have a serious impact upon beaver.

178. Skinner, Quentin D.; Speck, John E., Jr.; Smith, Michael; Adams, John C. 1984. Stream water quality as influenced by beaver within grazing systems in Wyoming. Journal of Range Management. 37(2): 142-146.
During the summers of 1979 and 1980 on a mountain rangeland near Laramie, WY, streams were tested for bacteria as indicators of pollution, and were studfied for differences between grazing treatments and streams. Variation in counts of fecal coliform and streptococci could not be fully accounted for by differences in grazing management, but the variation is partially explained by beaver damming of stream flow.

179. Slough, B. G.; Sadleir, R. M. F. S. 1977. A land capability classification system for beaver (*Castor canadensis* Kuhl). Canadian Journal of Zoology. 55(8): 1324-1335.
The authors provide a model of the relationship of beaver to their habitat, a means of beaver inventory, a basis for beaver management, a land capability methodology, and the development of a land capability classification system for beaver.

180. Slough, Brian G. 1978. Beaver food cache structure and utilization. Journal of Wildlife Management. 42(3): 644-646.
Observations were made at 115 colony sites within a 100-km radius in the northern interior of British Columbia, May through August 1974 and 1975 and October 1974. Raft constituents are selected both for their availability and their ability to submerge and secure the cache. Because preferred foods are frequently used for this purpose, the beaver does not attempt to conserve the food resource by using nonfood and low preference food species in the raft.

181. Slough, Brian; Jessup, Harvey. 1983. 1982-83 furbearer inventory, habitat assessment and trapper utilization of the Yukon River Basin. In: Proceedings of the Alaska science conference; 1983 September 28-October 1; Whitehorse, Yukon Territory. Fairbanks, AK: American Association for the Advancement of Science, Arctic Division: 164.
Yukon Department of Renewable Resources conducted an inventory in the Yukon River Basin in 1982 and 1983. Beaver food cache and colony site surveys were analyzed in conjunction with an ongoing trapper questionnaire and historical fur harvest data. The authors discuss the fur resource capability and problems and issues associated with impacts on furbearer populations, habitats, and user groups.

182. Smith, Bruce H. 1980. Not all beaver are bad; or, an ecosystem approach to stream habitat management, with possible software applications. In: Whaley, R., ed. Proceedings, 15th annual meeting Colorado-Wyoming Chapter, American Fisheries Society; 1980 February 27-28; Fort Collins, CO: [Publisher and city unknown]: 32-37
Smith looks at the feasibility of using computer software to help improve stream habitats for beaver.

183. Spieth, Herman T. 1979. The *virilis* group of *Drosophila* and the beaver *Castor*. The American Naturalist. 114(2): 312-316.
Species of the *virilis* group, except the primitive *D. virilis*, are semiobligatory commensals of the beaver. The decimation of the beaver population during the 18th and 19th centuries resulted in a drastic reduction of the *virilis* species group populations.

184. Stock, A. Dean. 1970. Notes on mammals of southwestern Utah. Journal of Mammalogy. 51(2): 429-433.
A beaver specimen (*Castor canadensis repentinus* Goldman) was collected from southwestern Utah, showing an extension of range.

185. Suk, Thomas J. 1983. Investigation of animal hosts for *Giardia* spp. in California's Sierra Nevada Mountains. Tech. Rep. 11. Davis, CA: Cooperative National Park Resources Studies Unit. 21 p.
During the summer of 1982 mammalian fecal samples were collected in the Sierra Nevada Mountains in an attempt to clarify the epidemiology of the disease giardiasis by identifying potential host-reservoirs.

186. Suttkus, Royal D.; Clemmer, Glenn H.; Jones, Clyde. 1978. Mammals of the riparian region of the Colorado River in the Grand Canyon area of Arizona. Occas. Pap. 2. New Orleans, LA: Tulane University, Museum of Natural History. 23 p.

The authors provide some basic information on the mammals that occur along the Colorado River in the Grand Canyon and identify locations of materials and related information for use by biologists and others. Float trips to collect the data occurred periodically from September 1970 to September 1976.

187. Svendsen, Gerald E. 1980. Seasonal change in feeding patterns of beaver in southeastern Ohio. Journal of Wildlife Management. 44(1): 285-290.

The author analyzed data collected between 1974 and 1977 to determine beavers' use of woody and nonwoody vegetation for food and to quantify seasonal changes in use of different types of vegetation.

188. Swenson, Jon E.; Knapp, Stephen J.; Martin, Peter R.; Hinz, Thomas C. 1983. Reliability of aerial cache surveys to monitor beaver population trends on prairie rivers in Montana. Journal of Wildlife Management. 47(3): 697-703.

Aerial surveys proved to be unreliable in indicating beaver population size or trend but were accurate in locating caches and were constant among years and areas.

189. Taylor, David. 1971. Beaver population studies at Sagehen Creek. In: Transactions California-Nevada Section, The Wildlife Society; 1971 January 29-30; Sacramento, CA. Smartsville, CA: The Wildlife Society: 18-19.

Taylor, briefly discussing the history of beaver introduction at Sagehen Creek in the Sierra Nevada from 1945 through 1970, shows that periods of rapid growth and high population were dependent upon standing crop of aspen.

190. Taylor, K. P. 1983. Factors influencing beaver management in rural Alaska - northern Bristol Bay. Acta Zoologica Fennica. 174: 127-128.

Factors that influence harvest levels include the economic success or failure of the commercial salmon fishery in Bristol Bay prior to the trapping season and changes in weather conditions as they affect trapper mobility. The author explains how current trapping practices effectively prevent maximum sustained yield management, and reviews management alternatives.

191. Thomas, Allan E. 1986. Riparian protection/enhancement in Idaho. Rangelands. 8(5): 224-227.

Beaver moved into part of the Summit Creek study area, thus providing increased habitat for trout and waterfowl. Some of the original brushy species were killed by flooding from beaver dams, but new willows and birch plants appeared at the edges of the marshes about as fast as old plants were destroyed.

192. Thomas, Jack W.; Maser, Chris; Rodiek, Jon E. 1979. Wildlife habitats in managed rangelands - the Great Basin of southeastern Oregon: riparian zones. Gen. Tech. Rep. PNW-80. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 18 p.

Wildlife use riparian zones more than any other plant community. Of the 363 terrestrial species known to occur in the Great Basin of southeastern Oregon, 288, including the beaver, are either directly dependent on riparian zones or use them more than other habitats.

193. Thorne, E. T.; Williams, E. S.; Anderson, S. L. 1984. Diagnosis of diseases in wildlife. Job Performance Report, Research Project Segment. Cheyenne, WY: Wyoming Game and Fish Department. 32 p.

Researchers examined 126 specimens, diseased animals, eggs and tissue samples from July 1983 to June 1984. They found bacterial abscesses in two trapper-killed beaver. One also had extensive muscular fibrosis, and *Staphylococcus aureus* was recovered from the other.

194. Thorniley, Mike. 1972. The dam builders. Pacific Search. 7(3): 4-5.

The author looks at the beaver's dam construction habits.

195. Todd, Arlen W. 1981. Ecological arguments for fur-trapping in boreal wilderness regions. Wildlife Society Bulletin. 9(2): 116-124.

The author presents arguments for the ecological benefits of maintaining optimal beaver populations versus the disadvantages of overpopulation.

196. Todd, Arlen W.; Geisbrecht, Lori C. 1979. A review of Alberta fur production and management, 1920-21 to 1977-78. Edmonton, AB: Alberta Energy and Natural Resources, Fish and Wildlife Division. 64 p.

The report includes statistics on fur production and the fur industry in Alberta from 1920-21 to 1977-78. Beaver harvests in Alberta are inadequate today, and beaver are considered overabundant in many agricultural and suburban areas.

197. Toweill, Dale E.; Maser, Chris. 1985. Food of cougars in the Cascade Range of Oregon. The Great Basin Naturalist. 45(1): 77-80.

Animal and nonanimal items were identified in the digestive tracts of 61 cougars (*Felis concolor*) collected between 1978 and 1984. Beaver in the diet may have represented opportunistic feeding.

198. Vogt, Bill. 1981. What ails the river otter? National Wildlife. 19(2): 25-28.

The river otter often depends upon the beaver because the beaver's dam is a haven for fish, the otter's main food. Widespread efforts aimed at restoring beaver populations have also benefited the otter.

199. Wagner, Hugh M. 1983. The cranial morphology of the fossil beaver *Dipoides smithi* (Rodentia: Mammalia). Contributions in Science, Natural History Museum of Los Angeles County. 346: 1-6.

In 1974 a well-preserved skull was recovered from north-central Oregon. The cranial morphology was compared to that of other fossil beavers (*Eucastor* and *Castoroides*) and to present day *Castor* skulls.

200. Wallis, P. M.; Buchanan-Mappin, J. M. 1985. Detection of *Giardia* cysts at low concentrations in water using nuclepore membranes. Water Research. 19(3): 331-334.
Giardia cysts taken from the rectum and large intestine of a beaver, trapped commercially near Ribbon Creek in the Kananaskis Valley of Alberta, were added to 100 L of untreated stream water and recovered by filtration. Recovery efficiencies averaged 53 percent at cyst concentrations between 0.5 and 45 cysts per liter. Maximum cyst recovery was observed at filtration pressures of 40-60 kPa. This method results in higher recovery efficiencies at low cyst concentrations and simpler, more rapid laboratory procedures.

201. Wallis, P. M.; Buchanan-Mappin, J. M.; Faubert, G. M.; Belosevic, M. 1984. Reservoirs of *Giardia* spp. in southeastern Alberta, Canada. Journal of Wildlife Diseases. 20(4): 279-283.
A survey of potential hosts of *Giardia* spp. was carried out during 1982 and 1983 in the Kananaskis Valley and Banff National Park, AB, Canada. Positive samples were found from two of 58 beavers sampled.

202. Wallis, P. M.; Zammuto, R. M.; Buchanan-Mappin, J. M. 1986. Cysts of *Giardia* spp. in mammals and surface waters in southwestern Alberta. Journal of Wildlife Diseases. 22(1): 115-118.
Researchers conducted a survey of animal feces and surface water supplies from 1983 to 1984 to evaluate the potential for zoonotic transmission of giardiasis by surface waters in the Kananaskis-Banff area. Initial results showed that 3.5 percent of beaver fecal samples contained *Giardia* spp. cysts.

203. Watson, G. H.; Prescott, W. H.; de Bock, E. A.; Nolan, J. W.; Dennington, M. C.; Poston, H. J.; Stirling, I. G. 1973. An inventory of wildlife habitat of the Mackenzie Valley and the northern Yukon. Task Force on Northern Oil Development Report 73-27; Environmental-Social Committee Northern Pipelines. Edmonton, AB: Department of the Environment, Canadian Wildlife Service. 152 p.
The authors seek to place in perspective the kinds of factors associated with beaver populations within the study area. Identification of habitat and descriptions of habitat types provide information for land-use planning programs or for more detailed research.

204. Wilson, H. S. P.; Stauffer, S. J.; Walker, T. S. 1982. Waterborne giardiasis outbreak - Alberta. Canada Diseases Weekly Report. 8(20): 97-100.
Beaver fecal samples were tested for giardiasis along Forty-Mile Creek in Banff, AB, Canada in March 1982. All of the fecal samples tested positive for *G. lamblia*.

205. World Wildlife Illustrated. 1970. The American beaver (*Castor canadensis*). World Wildlife Illustrated. 2(1): 4-6.
The report briefly discusses the life history and seasonal activity of the North American beaver.

206. Youngman, Phillip M. 1975. Mammals of the Yukon Territory. National Museum of Natural Sciences, Publications in Zoology. 10: 77-79.
The author describes the distribution of *Castor canadensis* Kuhl.

SUBJECT INDEX

An asterisk (*) indicates references listed under more than one subject category.

Medin, Dean E.; Torquemada, Kathryn E. 1988. Beaver in Western North America: an annotated bibliography, 1966 to 1986. Gen. Tech. Rep. INT-242. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 18 p.

This annotated bibliography of 206 references is provided as a working tool for natural resource specialists, land-use planners, and others charged with managing beavers and their habitats. References include both technical and popular articles. Emphasis is on the Western United States and Canada.

KEYWORDS: *Castor canadensis*, management, ecology, life history

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